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FINAL RISK ASSESSMENT

FOR

BUSH VALLEY LANDFILL

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BUSH VALLEY LANDFILL

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BUSH VALLEY LANDFILL

BASELINE RISK ASSESSMENT FOR RI/FS

EXECUTIVE SUMMARY

Soil, groundwater, surface water, sediment, air, and leachate were considered to be the media of potential concern with regard to quantitative risk assessment. Because of the site's location in a residential area and the fact that future uses of relevant media are unknown, the receptors were assumed to be residents. This assessment constitutes an evaluation of the no-action alternative required under section 300.68 (f) (v) of the National Contingency Plan (NCP). The Baseline Risk Assessment follows EPA guidance for risk assessment in general and for Superfund sites in particular (USEPA, 1989).

The calculated risks exceeded a Hazard Index (HI) of 1 and/or an estimated cancer risk of 1E-4 in groundwater from monitoring wells and one residential well. If Area 1 monitoring well water were to be used at the reported concentrations by residents, the HI would exceed 1 because of manganese, arsenic, and VOCs singly and in combination. The overall estimated cancer risk would also exceed 1E-4. If Area 2 monitoring well water were to be used at the reported concentrations by residents, the HI would exceed 1 because of manganese. The overall estimated cancer risk would exceed 1E-4. For child residents consuming water from the Washington well (if such exposure were to occur), the HI would be greater than 1, due to the reported concentration of manganese. The ingestion route contributed the bulk of the risk. However, uncertainty plays a major role in the interpretation of this result.

For other media that were quantitatively evaluated, estimated cancer risks fell in or below the range from 1E-6 to 1E-4, and HIs were less than 1.0. The air sampling results were not deemed adequate for a full quantitative baseline risk assessment.

1.0 INTRODUCTION

In the baseline risk assessment, the hazards posed by chemicals detected during the Remedial Investigation (RI) are evaluated. Potential risks may exist when there are chemicals present in media and receptors which have access to the chemicals. This constitutes a complete exposure pathway.

To evaluate these risks, several steps are taken. First, the data are assessed for usability and comparability. The data quality objectives outlined in the work plan should have been met. Data may then undergo statistical manipulations for use in the quantitative risk assessment. In Region III, an initial screening step occurs during data evaluation for the purposes of narrowing down the list of chemicals that is quantitatively assessed. Using conservative assumptions, the chemical concentrations that would correspond to the lower end of the target risk range are calculated. These concentrations are called risk-based concentrations, or RBCs, and are compared to the site data during the data evaluation stage to rule out chemicals that will not contribute significantly to risks at the site.

Reasonable maximum exposure pathways are then determined. The receptors that may be exposed are also chosen. One advantage of considering reasonable maximum exposure is that resulting conclusions would also be expected to be protective of any receptors receiving less exposure. Both current and future land uses must be considered. Using site-specific or default assumptions, estimated exposure doses are calculated for each receptor.

Once the amount of exposure each receptor receives has been calculated, that amount or dose is compared with values designed to assess the safety or toxicity of a chemical. This step, which is called risk characterization, helps the risk assessor determine the likelihood of adverse effects occurring for that exposure scenario.

Finally, the uncertainty of the risk analysis is defined, either quantitatively, qualitatively, or both. This step helps give a more complete picture of site-associated risks, and helps risk managers weigh their options in addressing potential site hazards.

The following sections give a detailed explanation of how these steps were performed for the Bush Valley Landfill site.

2.0 DATA EVALUATION

Chemical analyses were conducted for soil, groundwater,

surface water, sediment, air, and leachate, as discussed in Section 3.0 of the RI. The analytical methods and data quality are discussed in detail in Volume 3 of the RI.

2.1 Chemicals of Potential Concern

Soil, groundwater, surface water, sediment, air, and leachate were considered to be the media of potential concern with regard to quantitative risk assessment. The data were examined in order to determine chemicals of potential concern (COPCs). COPCs are defined as those substances that are potentially site-related and whose data are of sufficient quality for use in the risk assessment. It is appropriate to select COPCs for each medium of concern.

2.1.1 Soil

2.1.1.1 Surface Soil

Soil was collected from the surface, and from borings (subsurface soil) at various depths. The surface samples are considered to be appropriate for the evaluation of surface soil under current conditions.

Tables 7 and 7A summarize surface soil results for confidently detected chemicals. The maximum positive detections of chemicals in soil were compared with 1) RBCs and 2) background concentrations.

Screening RBCs were used to determine whether, if included in the risk assessment, the chemical would be likely to contribute significantly to the risk. The screening concentrations were based on the following exposure assumptions:

For carcinogens, residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days per year, divided into lifetime segments of 6 years at 15 kg body weight, ingesting 200 mg of soil per day, and 24 years at 70 kg, ingesting 100 mg/day.

For noncarcinogens, a six-year childhood exposure was assumed, with a 15-kg child consuming 200 mg of soil per day, 350 days per year. For noncarcinogens, the child-only scenario is more conservative than the age-adjusted 30-year scenario.

Using these assumptions, the RBCs were calculated at target risks of Hazard Quotient (HQ) = 0.1 (one-tenth the no-effects dose) and cancer risk = 1E-6 (probability of excess cancer cases 1 in 1,000,000). Calculation of HQs and estimated cancer risks is discussed in detail in Section 4.1.

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Soil samples SUS1, SUS2, and SUS3 were originally designed to represent "background" conditions. SUS1 was located west of the site, and SUS2 and SUS3 were located on the north bank of Bynum Run. SUS2 and SUS3 had, in many cases, higher chemical concentrations than SUS1. It has been stated in the RI that SUS2 and SUS3 may be affected by non-site-related contamination. While that possibility cannot be ruled out, it should also be noted that Bynum Run is downslope of the Bush Valley site and has been reported to flood the north bank. SUS2 and SUS3 also cannot be assumed to be free of influence from the site. Because of these issues, comparisons to background show all three intended background samples next to on-site maximums, and exceedance of any of the background samples was considered to be worthy of mention during the screening stage.

The following criteria were used to select inorganic COPCs in surface soil:

All chemicals whose maximum results exceeded all background results and the RBC (non-water-based) were selected as COPCs. These included beryllium, vanadium, and chromium. It should be noted that the beryllium results in SUS2 and SUS3 also exceeded the RBC for this chemical. Chemicals less than background and the RBC, or less than one where the other does not exist, were not selected as COPCs. Chemicals that are essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected as COPCs. It should be noted that if the arsenic result for the split sample SUS5 were used, arsenic would also be selected as a COPC using the above criteria. Therefore, surface soil was evaluated both with and without arsenic.

Aluminum, barium, copper, manganese, cyanide, mercury, nickel, and zinc exceeded at least one background concentration, but were less than the RBC. Because of the limited number of background samples and the difficulty interpreting them at this site (as discussed above), it is difficult to determine the appropriate range of background concentrations, and any or all of these chemicals (except cyanide) could be naturally occurring. Also, the RBC screening indicated that these chemicals, even if quantitatively assessed in the baseline risk assessment, would not contribute significantly to the risk. Therefore, it is noted here that these constituents may be elevated in surface soil, but not at concentrations expected to significantly impact overall direct-contact risk.

Cobalt and iron, although apparently greater at on-site levels than in background soil, are essential nutrients. There was no evidence to indicate that these chemicals should pose a direct-contact hazard at the reported concentrations, and they were eliminated from consideration as COPCs.

Lead is more difficult to assess. The maximum concentration exceeded background, and no RBC is available. The lack of an identifiable threshold for effects from increased blood lead has confounded efforts to set a "no-effects" level, on which screening could be based. However, lead in Region III is assessed using the uptake/biokinetic (UBK) model. The model inputs and outputs are shown in Appendix A, including one run of the model using all the defaults. Using default parameters for typical childhood lead exposure, blood lead levels of approximately 3 ug/dL are estimated. The contribution from soil and dust lead at 200 mg/kg is approximately half of this, about 1.5 ug/dL. Effects such as anemia are generally not observed until concentrations of 40 ug/dL, and encephalopathy above 60 ug/dL (Doull et al, 1986). Current research is focusing on the range below 10 ug/dL, where subtle metabolic and nervous sytem effects are suspected. Therefore, lead results less than 200 mg/kg were not quantitatively evaluated as a COPC, since they would result in contributions lower than typical or "default" lead exposures and would be of doubtful significance in contributing to overall lead exposure.

Selection of organic COPCs was approached using the same principles. Most organic compounds on the Target Compound List (TCL) are not naturally occurring, although some polycyclic aromatic hydrocarbons (PAHs) are. PAHs and phthalates also may be detected from non-site-related activities, because these chemicals are especially ubiquitous from anthropogenic sources. For these reasons, comparison to background soil and RBCs were again used to select COPCs.

Most of the organic chemicals detected in on-site surface soil (acetone, bis(2-ethylhexyl) phthalate, benzo[b]fluoranthene, fluoranthene, pyrene) had maximum concentrations exceeding all background concentrations, but not RBCs. The maximum concentration of di-n-butyl phthalate was less than the reported background concentration. Many of these chemicals were detected in other on-site media and may be site-related. However, screening with RBCs showed that these chemicals are not expected to contribute significantly to direct-contact risk. Therefore, they were not quantitatively evaluated as COPCs.

A brief screening was conducted to determine whether any of the surface soil chemicals should be evaluated as contributors to fugitive dust emissions. In the unlikely event that enough dust were generated at the site to meet the annual average National Ambient Air Quality Standard of 50 ug/m^3 PM10 in air (40 CFR 50.6), and assuming the 70-kg adult would inhale 20 m^3 air/day, it was determined that the screening target risks would not be exceeded for almost all of the COPCs. The exceptions were chromium and manganese, which were considered to warrant quantitative risk evaluation for this pathway.

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Volatilization of chemicals from surface soil, given the type and amount of chemicals detected in surface soil, was not considered to be a significant pathway. Typically, volatile organic compounds (VOCs) in soil tend to evaporate rapidly or migrate to subsurface soil and groundwater. At this site, as expected, VOCs in subsurface soil were greater than those in surface soil. Volatilization of any importance would not be expected from surface soil. The subsurface data do not suggest that volatilization from exposed subsurface material at the sampled locations would warrant quantitative evaluation.

Additionally, if current conditions were to persist, continued migration of subsoil contaminants to groundwater would be a likely consequence. Actual groundwater data exist and were used to characterize this medium. However, the potential for future leaching may play a role in assessing potential remedies.

2.1.1.2 Subsurface Soil

Subsoil samples were taken from soil borings at various depths. For potential direct contact to human receptors, it is considered possible that such contact could occur during excavation activities or possibly future residential exposure if the material above the sample locations were removed.

To select COPCs for such exposure, maximum concentrations of on-site samples were compared with 1) risk-based concentrations and 2) background concentrations. Tables 18 and 18A summarize the data evaluation for subsurface soil.

The risk-based concentrations were the same as those used for soil exposure, since the same exposure scenario (although for hypothetical future instead of potential current exposure) would be used.

Soil samples GM1US, GM1LSS, GM7, and GM9 were originally designed to represent "background" conditions. GM1LSS and GM1US were located in the southernmost part of the site. GM9 was located west of the site, and GM7 was located on the north bank of Bynum Run. GM7 and GM9 had, in many cases, higher chemical concentrations than GM1LSS. It has been stated in the RI that GM7 and GM9 may be affected by non-site-related contamination. While that possibility cannot be ruled out, it should also be noted that Bynum Run is downslope of the Bush Valley site and has been reported to flood its north bank. Therefore, GM7, at least, cannot be assumed to be free of influence from the site. Because of these issues, comparisons to background show all three intended lower-sand background samples next to on-site maximums, and exceedance of any of the background samples was considered to be worthy of mention during the screening stage.

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Inorganic chemicals whose maximum concentrations exceeded at least one background sample and RBCs were selected as COPCs: beryllium, cadmium. Reported concentrations of aluminum, arsenic, barium, chromium, copper, manganese, mercury, nickel, vanadium, zinc, and tin exceeded at least one background concentration but were below RBCs. Therefore, even though concentrations of these elements may or may not be elevated in subsoil, they would not be expected to contribute significantly to direct-contact human health risk and were not selected as COPCs. Chemicals that are essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected as COPCs. Cobalt and iron, although apparently greater at on-site levels than in background soil, are essential nutrients. There was no evidence to indicate that these chemicals should pose a direct-contact hazard at the reported concentrations, and they were eliminated from consideration as COPCs.

The rationale for assessing lead was the same as that described under Section 2.1.1.1 for surface soil. Lead was not detected in subsurface soil at concentrations that would be expected to contribute notably to the risk and therefore was not included as a COPC.

Aroclor 1254 was selected as a COPC because it was detected on site at concentrations exceeding background as well as the RBC. Additionally, this mixture of polychlorinated biphenyls (PCBs) is not naturally occurring. Aroclor 1254 above the RBC was also detected in sample GM1LSS. Other organic chemicals detected above background concentrations in subsurface soil included methylene chloride, acetone, carbon disulfide, 2-butanone, 1,1-dichloroethane, toluene, benzene, trichloroethene, di-n-butyl phthalate, and 1,2-dichloroethane. However, these chemicals were detected below RBCs and were therefore not selected for quantitative risk assessment as COPCs.

It was not considered appropriate to combine all subsurface soil since the samples were all taken from different depths. The two borings with the highest concentrations of the COPCs were GM5 and GM8.

2.1.2 Monitoring Wells

Risk-based concentrations and "background," or "upgradient," well concentrations were also used to select inorganic COPCs for monitoring wells.

Both filtered and unfiltered samples were taken from the monitoring wells. Generally, it is preferable to use unfiltered samples as a truer measure of the metals concentrations in groundwater. However, monitoring well samples are often turbid

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or "muddy," in which case metals in unfiltered samples may be a measure of the suspended solids rather than the metals dissolved in the water. For this reason, the hydrogeologist and toxicologist compare filtered and unfiltered results and study field logs in order to select which set of samples best reflects the site-specific groundwater conditions.

At the Bush Valley Landfill site, most of the groundwater samples were described as being clear upon collection. A comparison of the unfiltered and filtered data showed that the concentrations of cations were similar between the two data sets, and it was decided that the unfiltered results would be used.

The risk-based concentrations were derived as follows:

For carcinogens, residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days per year, divided into lifetime segments of 6 years at 15 kg body weight consuming 1 liter per day and 24 years at 70 kg consuming 2 L/day. For noncarcinogens, the thirty-year adult-only scenario was used. Although monitoring wells are not currently potable, the conservative screening provides an indication of whether groundwater contamination exists and whether it could be hazardous if used in the future.

Using these assumptions, the RBCs were calculated at target risks of Hazard Quotient (HQ) = 0.1 (one-tenth the no-effects dose) and cancer risk = 1E-6 (probability of excess cancer cases 1 in 1,000,000). Calculation of HQs and estimated cancer risks is discussed in detail in Section 4.1.

The wells intended to be background wells were GM1US, GM1LSS, GM7, and GM9. The upper-sand aquifer does not appear to produce significant quantities of water over most of the site, and therefore the quantitative focus was on the wells in the lower-sand aquifer.

Because the site is located in a tidally influenced watershed, the intended upgradient wells GM1US, GM1LSS, and GM9 are less than 200 feet from the suspected landfill perimeter, the trenches were reported to be oriented in an east-west direction, and the gradient is very low, these wells may not be the best representatives of background or upgradient water quality. Well GM7, another intended upgradient well, was at a lower elevation than estimated water elevation contours on the other side of the creek. Therefore, the risk assessment separated these wells from the intended downgradient wells, but did not assume them to be necessarily uninfluenced by the site.

An examination of the data from onsite downgradient wells showed two potential concentrated areas of contaminants. While

VOCs were detected throughout the site, the center of this plume definitely appears to be in the vicinity of well nos. 2, 3, and 4. Consequently, wells GM2LSS, GM3, and GM4 were sampled three times each during the RI and comprised one of the groundwater areas (Area 1) selected for quantitative risk assessment.

On the north side of the landfill, the concentrations of organics were lower, but concentrations of metals in groundwater were higher. Therefore, GM5, GM6, and GM8 comprised the second groundwater area (Area 2) selected for quantitative risk assessment. Regional guidance speicifes that the most contaminated area/center of the plume should be targeted for groundwater assessment. Intersection of Area 1 and Area 2 contaminants appeared unlikely given the hydrogeology, and the two areas were assessed separately.

Tables 17 and 17A summarize the data evaluation for monitoring wells. In each of the two groundwater areas, the inorganics were compared to intended upgradient results and to RBCs. Drinking water criteria for public water supplies are also shown for comparison's sake. All inorganics greater than the RBC and the Maximum Contaminant Level (MCL) (or greater than one where the other does not exist) were selected as COPCs. This resulted in the selection of manganese in both areas. Common elements that are also essential nutrients (calcium, magnesium, potassium, sodium) were not selected. Chemicals with concentrations less than drinking water criteria but above RBCs were selected as COPCs: arsenic, beryllium, chromium in Area 1 and beryllium in Area 2. Aluminum in both areas exceeded a non-health-based criterion but was less than the RBC, and was not selected as a COPC. There was no evidence to indicate that cobalt and iron, which are essential metals, should pose a significant potential human health hazard in either area at reported concentrations. Lead was detected in Area 1 groundwater at concentrations less than the default concentration for the UBK model and less than the drinking water criterion, and was therefore not quantitatively assessed. Cadmium was also detected in an Area 1 split sample at 5.8 ug/l, exceeding the RBC, and arsenic was detected in an Area 1 split sample at a higher concentration (5 ug/l) than the previously reported maximum. Therefore, Area 1 groundwater was evaluated both with and without split data.

While the metals were generally found at higher concentrations in on-site than intended upgradient well samples, some of the intended background samples also had potentially significant concentrations: beryllium, cadmium, manganese, and nickel in GM1LSS, and manganese in GM7 and GM9.

For organics, none of the compounds detected in the wells is believed to be naturally occurring. However, only those detected

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at concentrations approximately equal to or greater than RBCs (vinyl chloride, 1,2-dichloroethene, 1,2-dichloroethane, 1,2-dichloropropane, benzene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, and trichloroethene in Area 1; vinyl chloride, 1,2-dichloroethane, and alpha-hexachlorocyclohexane in Area 2) were selected as COPCs. Heptachlor epoxide was also detected in an Area 1 split sample at 0.005 ug/l, exceeding the RBC of 0.0015 ug/l. Therefore, Area 1 groundwater was evaluated both with and without heptachlor epoxide.

Concentrations of beryllium, manganese, nickel, benzene, trichloroethene, and tetrachloroethene in the intended background upper sand well GM1US also exceeded RBCs. Because this was the only on-site well representing the upper sand unit, the quantitative evaluation for this well was performed separately. Tables 24 and 25 present the data evaluation and COPCs for this well.

Unknown compounds were tentatively identified in the monitoring well samples. In samples from Area 1, chlorinated benzenes and alkylbenzenes were tentatively identified as well as confidently identified. Alkylhydrazine and phosphoric acids (one a neurotoxicant) were also tentatively identified in monitoring wells. Because the identity and quantitation of tentatively identified compounds (TICs) are so uncertain, they are not used in quantitative risk assessment. The confidently identified chlorinated benzenes and alkylbenzenes in these wells were evaluated.

2.1.3 Residential Wells

Three residential wells south of the site were sampled. It is reported that none of these wells are currently used for drinking, although they may be used for gardening or car washing. Screening and risk analysis enable the assessor to determine whether the groundwater is of potable quality, regardless of current uses. A residential well is considered to be a potential point of exposure; therefore, all residential wells were assessed individually.

For the selection of COPCs in residential wells, RBCs (derived for groundwater as described in the previous section) were used. Drinking water criteria are also shown on the data evaluation tables for residential wells for comparison's sake.

2.1.3.1 Milton Well

Two rounds of RI sampling, one of which consisted of duplicate samples, were available for the Milton well. The data evaluation for this well is summarized in Table 1. Chemicals that are essential nutrients and common minerals (calcium, iron,

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magnesium, potassium, and sodium) were not selected as COPCs. Cobalt is also an essential chemical. There was no evidence to indicate that this chemical should pose a significant hazard at the reported concentrations, and it was also eliminated from consideration as a COPC. Chemicals whose maximum concentrations from both rounds were less than RBCs were also not selected as COPCs. Manganese was selected as a COPC because the maximum concentration exceeded the RBC.

No organic chemicals were confidently or tentatively identified in samples from this well.

2.1.3.2 Fleet Well

Two rounds of RI samples plus split samples obtained by the USEPA contractor were available for the Fleet well. The data evaluation for this well is summarized in Table 2. Chemicals that are essential nutrients and common minerals (calcium, iron, magnesium, potassium, and sodium) were not selected as COPCs. Chemicals whose maximum concentrations from both rounds were less than RBCs were also not selected as COPCs. Manganese was selected as a COPC because the maximum concentration exceeded the RBC.

Lead, as previously noted, is assessed differently than other COPCs. Lead was only positively detected in the split sample. Therefore, lead would be selected as a COPC because of the lack of an identifiable threshold and was assessed using the UBK model.

No organic chemicals were confidently or tentatively identified in samples from this well.

2.1.3.3 Washington Well

Two rounds of RI samples were available for the Washington well. The data evaluation for this well is summarized in Tables 3 and 3A. Chemicals that are essential nutrients and common minerals (calcium, iron, magnesium, potassium, and sodium) were not selected as COPCs. Chemicals whose maximum concentrations from both rounds were less than RBCs were also not selected as COPCs. Manganese was selected as a COPC because the maximum concentration exceeded the RBC.

It should be noted that alpha-HCH (alpha-hexachlorocyclohexane, also called alpha-BHC) was detected in the first round from this well at a concentration below both the RBC and the MCL. This chemical was not detected in the second round of sampling. This chemical is not expected to be naturally occurring but was not detected at a concentration that would be associated with significant risks as a constituent of potable

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water. Therefore, this chemical was not quantitatively evaluated as a COPC.

2.1.4 Surface Water

Several different types of surface water samples were obtained. They included samples from constantly flowing streams such as Bynum Run and James Run, intermittent streams or drainage ditches, on-site basins, and a tributary that originates in a marsh. These surface water types were assessed separately and were grouped as follows:

STREAM
Upstream: SW-1, SW-5
Downstream: SW-3, SW-4, SW-6

INTERMITTENT STREAM/DRAINAGE DITCH:
SW-2

ON-SITE BASINS:
SW-8
SW-9

TRIBUTARY ORIGINATING IN MARSH:
SW-7

Unfiltered inorganic results were used for surface water in the assessment of human health effects, because any direct contact would occur with the water in its unfiltered state, including any suspended sediments.

Stream surface water COPCs were selected by comparing downstream results to both upstream results and RBCs. The surface water RBCs were derived using the following assumptions: 30-year exposure (simplified as 6 years at 15 kilograms and 24 years at 70 kilograms) during swimming, with incidental ingestion of 50 mL/hr of surface water, with each swimming event lasting 4 hours and occurring 7 times/year, based for the most part on suggested inputs from USEPA, 1989. Again, the target risks were HQ = 0.1 and estimated cancer risk = 1E-6. Other surface water areas, which could not easily be compared to appropriate "upstream" concentrations, were selected mainly by the use of RBCs.

2.1.4.1 Stream Surface Water

Tables 4 and 4A summarize the data evaluation for stream surface water. Chemicals whose maximum concentrations were less than both upstream concentrations and RBCs, or less than one where the other does not exist, were not selected as COPCs.

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Chemicals that are both essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected.

Concentrations of manganese in SW-3, SW-4 and SW-6 were greater than concentrations observed in upstream surface water. However, the results are less than RBCs for direct contact with surface water, and adverse human health effects are not anticipated. The concentrations of iron in SW-4 and SW-6 were greater than concentrations observed in upstream surface water. However, iron is an essential nutrient. There was no evidence to indicate that this chemical should pose a direct-contact hazard at the reported concentrations, and it was eliminated from consideration as a COPC.

Only one organic chemical was confidently identified in stream surface water; alpha-HCH was detected upstream of the site at a concentration less than the RBC. Therefore, no organic chemicals were selected as COPCs in stream water.

In summary, while some chemicals appeared to have been elevated downstream of the site, none of them posed risks that would warrant quantitative evaluation as COPCs. It was seen through the screening process that significant adverse human health effects would not be expected.

2.1.4.2 Intermittent Stream/Drainage Ditch (SW-2)

Table 15 summarizes the inorganic data evaluation for sample SW-2. The results were compared to surface water RBCs, since no upgradient sample was available for this location. Chemicals whose maximum concentrations were less than RBCs were not selected as COPCs. Chemicals that are both essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected. Iron and cobalt are essential nutrients. There was no evidence to indicate that these chemicals should pose a direct-contact hazard at the reported concentrations, and they were eliminated from consideration as COPCs.

Lead was detected in SW-2 at 8.2 ug/l. The lack of an identifiable threshold for effects from increased blood lead has confounded efforts to set a "no-effects" level, on which screening could be based. However, lead in Region III is assessed by the biokinetic model. Using default parameters for typical childhood lead exposure, blood lead levels of approximately 3 ug/dL are estimated. The contribution from surface water through a conservative swimming exposure (estimated ingestion 0.2 L/day) with lead at 8.2 ug/l in the surface water would not noticeably change the estimated blood lead levels. Therefore, this lead result was not quantitatively evaluated, since it would not contribute significantly to overall lead exposure. No inorganic chemicals were selected as COPCs.

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No organic chemicals were confidently identified in sample SW-2.

2.1.4.3 Onsite Basins (SW-8, SW-9)

Because no true upstream samples exist for basin sediments, COPC screening was performed using surface water RBCs.

SW-8

Table 9 summarizes the inorganic data evaluation for sample SW-2. Chemicals whose maximum concentrations were less than RBCs were not selected as COPCs. Chemicals that are both essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected. Iron is an essential nutrient. There was no evidence to indicate that this chemical should pose a direct-contact hazard at the reported concentration, and it was eliminated from consideration as a COPC.

Lead was detected in SW-8 at 3.5 ug/l. As discussed previously, such a concentration of lead in surface water would not noticeably change the estimated default blood lead levels. Therefore, this lead result was not quantitatively evaluated in the risk assessment, since it would not contribute significantly to overall lead exposure.

Table 9A presents the organic data evaluation for SW-8. Carbon disulfide was detected in SW-8. However, the concentration was below the RBC and would not be expected to pose a significant direct-contact human health hazard.

SW-9

Table 10 summarizes the inorganic data evaluation for sample SW-2. Chemicals whose maximum concentrations were less than RBCs were not selected as COPCs. Chemicals that are both essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected. Iron is an essential nutrient. There was no evidence to indicate that this chemical should pose a direct-contact hazard at the reported concentration, and it was eliminated from consideration as a COPC.

Lead was detected in SW-9 at 2.3 ug/l. As discussed previously, such a concentration of lead in surface water would not noticeably change the estimated default blood lead levels. Therefore, this lead result was not quantitatively evaluated in the risk assessment, since it would not contribute significantly to overall lead exposure.

Table 10A summarizes the organic data evaluation for SW-9. Carbon disulfide was detected in SW-9. However, the concentration was below the RBC and would not be expected to pose

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a significant direct-contact human health hazard.

In summary, it may be said that although lead and carbon disulfide might be considered to be contaminants of basin surface water, the chemicals were not present at concentrations that would be associated with significant human health risks. The carbon disulfide levels were low, and volatilization of this compound from the surface water would be expected to be negligible.

2.1.4.4 Tributary Originating in Marsh (SW-7)

Because there was no true upstream sample for this surface water body, COPCs were selected by using RBCs.

Chemicals whose maximum concentrations were less than RBCs were not selected as COPCs. Chemicals that are both essential nutrients and common minerals (calcium, iron, magnesium, potassium, and sodium) were not selected.

Manganese concentrations in both sampling rounds exceeded the RBC. Manganese was therefore selected as a COPC for SW-7.

No organic chemicals were confidently identified in sample SW-7.

2.1.5 Sediment

Several different types of sediment samples were obtained. They included samples from constantly flowing streams such as Bynum Run and James Run, intermittent streams or drainage ditches, on-site basins, marshes, and a tributary that originates in a marsh. The marshes were divided into two areas as follows: the northern floodplain forest and transition zone samples were grouped as Area 1, and the eastern upland forest/tidal freshwater marsh samples were grouped as Area 2. The sediment types were assessed separately and were grouped as follows:

STREAM
Upstream: SD-1, SD-5
Downstream: SD-3, SD-4, SD-6

INTERMITTENT STREAM/DRAINAGE DITCH:
SD-2

ON-SITE BASINS:
SD-8
SD-9

TRIBUTARY ORIGINATING IN MARSH:
SD-7

MARSH SEDIMENT, AREA 1:
MSD-1
MSD-2
MSD-3
MSD-4
MSD-5

MARSH SEDIMENT, AREA 2:
MSD-6
MSD-7
MSD-8
MSD-9

Whenever possible, COPCs were selected based on comparisons with upstream sediments and RBCs. RBCs were the same as those used for soil. Even though sediment exposure is expected to occur less often than soil exposure, the screening tends to err on the conservative side and was therefore considered acceptable for the selection of sediment COPCs.

2.1.5.1 Stream Sediment

Table 5 summarizes the inorganic data evaluation for stream sediment. Maximum downstream sediment concentrations were compared to the range of upstream concentrations and to RBCs for the selection of COPCs. Chemicals in downstream sediment samples whose maximum concentrations were less than both upstream concentrations and RBCs, or less than one where the other does not exist, were not selected as COPCs. Chemicals that are both essential nutrients and common minerals (calcium, magnesium, potassium, and sodium) were not selected.

Downstream concentrations of aluminum, barium, and cyanide at SD-6 exceeded upstream concentrations. The copper concentration at SD-3 (split sample) also exceeded upstream concentrations. These concentrations are less than RBCs and would not contribute significantly to a direct-contact risk. SD-6 appears to be the sample farthest downstream of the site.

The beryllium concentrations in downstream samples were less than those in upstream samples. However, the result at SD-3 (split) exceeded the RBC, as did the result at upstream SD-1. The beryllium may not be site-related. However, the result from this split sample was included as a COPC in order to evaluate its contribution to local risk. It is noted here, for risk management purposes, that the beryllium in the downstream sediment sample may not be attributable to the site.

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Several downstream manganese concentrations exceeded those in upstream sediments. However, these concentrations would be less than an RBC based on the Reference Dose (RfD) for manganese in food and would not contribute significantly to a direct-contact risk. Therefore, manganese was not selected as a COPC.

Table 5A summarizes the organic data evaluation for downstream stream sediment. The organic sediment results were compared to upstream concentrations and RBCs. 1,2-Dichloropropane was detected only in upstream sediment (SD-5) and was not selected as a COPC.

2.1.5.2 Intermittent Stream/Drainage Ditch Sediment (SD-2)

Table 11 summarizes the inorganic data evaluation for SD-2. Because background/upstream sediment data were not available for this sampling location, RBCs were used for the selection of COPCs. The concentrations of arsenic, beryllium, and manganese (based on RfD for food) exceeded RBCs, and these chemicals were selected as COPCs. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. The rationale for assessing lead was similar to that described under Section 2.1.1 for soil. The reported ocncentration of lead would not be expected to contribute significantly to overall risk; lead was therefore not included as a COPC in SD-2.

No organic chemicals were confidently identified in SD-2.

2.1.5.3 Onsite Basin Sediments (SD-8, SD-9)

Because background/upstream sediment data were not available for basin sediments, RBCs were used for the selection of COPCs.

SD-8

Table 13 summarizes the inorganic data evaluation for SD-8. Chemicals with concentrations less than RBCs were not selected as COPCs. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. Cyanide, which is not believed to be naturally occurring, was detected in this sample. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

Table 13A summarizes the organic data evaluation for SD-8. Bis(2-ethylhexyl) phthalate, which is not expected to be naturally occurring, was detected in SD-8. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

No COPCs were selected for the basin sediment at location

SD-8, since all chemicals detected there met the above screening criteria.

<u>SD-9</u>

Table 14 summarizes the data inorganic data evaluation for SD-9. The concentrations of arsenic, beryllium, and vanadium in split samples only approached or exceeded RBCs, and these chemicals could be selected as COPCs. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. The rationale for assessing lead was similar to that described under Section 2.1.1 for soil. The reported concentration of lead would not be expected to contribute significantly to overall risk; lead was therefore not included as a COPC in SD-9. Cyanide, which is not believed to be naturally occurring, was detected in this sample. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

Table 14A summarizes the organic data evaluation for SD-9. Bis(2-ethylhexyl) phthalate, which is not expected to be naturally occurring, was detected in SD-9. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

2.1.5.4 Tributary Originating in Marsh (SD-7)

Table 12 presents the inorganic data evaluation for SD-7. The concentrations of aluminum, arsenic, beryllium, chromium, vanadium, and manganese (based on RfD for food) were approximately equal to or exceeded RBCs, and these chemicals were selected as COPCs. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. The rationale for assessing lead was similar to that described under Section 2.1.1 for soil. The reported concentration of lead would not be expected to contribute significantly to overall risk; lead was therefore not included as a COPC in SD-7.

No organic chemicals were confidently identified in SD-7.

2.1.5.5 Marsh Sediment

Tables 6 and 6A summarize the data evaluation for both marsh areas.

<u>AREA 1</u>

Because no true "background" sample was available for marsh sediment, COPCs were selected based on RBCs. Chemicals detected at maximum concentrations greater than RBCs were selected as

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COPCs: arsenic, beryllium, chromium, vanadium. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. The rationale for assessing lead was similar to that described under Section 2.1.1 for soil. The reported concentration of lead would not be expected to contribute significantly to overall risk; lead was therefore not included as a COPC in Area 1. Chemicals detected at concentrations less than RBCs were not selected. Cyanide, which is not believed to be naturally occurring, was detected in marsh sediment from this area. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

1,2-Dichloropropane, di-n-butyl phthalate, bis(2-ethylhexyl) phthalate, benzo[b]fluoranthene, fluoranthene, and pyrene, which are not expected to be naturally occurring, were detected in marsh sediment from this area. However, the concentrations were less than RBCs, and these chemicals were not selected for quantitative evaluation as COPCs.

AREA 2

Chemicals detected at maximum concentrations greater than RBCs were selected as COPCs: aluminum, arsenic, beryllium, chromium, vanadium. In fact, the arsenic result in the split sample was even higher still than the value that caused arsenic to be selected as a COPC. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. The rationale for assessing lead was similar to that described under Section 2.1.1 for soil. The reported concentration of lead would not be expected to contribute significantly to overall risk; lead was therefore not included as a COPC in Area 2. Chemicals detected at concentrations less than RBCs were not selected. Cyanide, which is not believed to be naturally occurring, was detected in marsh sediment from this area. However, the concentration was less than the RBC, and this chemical was not selected as a COPC.

Di-n-butyl phthalate, butylbenzyl phthalate, bis(2-ethylhexyl) phthalate, benzo[b]fluoranthene, fluoranthene, and pyrene, which are not expected to be naturally occurring, were detected in marsh sediment from this area. However, the concentrations were less than RBCs, and these chemicals were not selected for quantitative evaluation as COPCs.

2.1.6 Leachate

Because leachate has no true background samples, COPCs were generally selected by comparison with RBCs using the surface water assumptions. Such RBCs may be somewhat conservative, since the quantity of leachate is not expected to support swimming uses, and leachate is not reported to flow year-round or even in

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the warmer months when surface water exposure is more likely.

Table 16 summarizes the inorganic data evaluation for leachate. Chemicals with maximum concentrations less than the RBCs were not selected as COPCs. Chemicals that are essential nutrients (calcium, iron, cobalt, magnesium, potassium, and sodium) were not selected. Manganese, which exceeded the RBC, was selected as a COPC. Lead, which was detected at concentrations much greater than in surface water at locations on and around the site, was also selected as a COPC.

Table 16A summarizes the organic data evaluation for leachate. Toluene, 4-methylphenol, 2,4-dimethylphenol, 1,4-dichlorobenzene, 1,2-dichlorobenzene, naphthalene, 2-methylnaphthalene, diethyl phthalate, gamma-BHC, and heptachlor were detected in leachate samples. These chemicals are generally not believed to be naturally occurring. However, screening with RBCs indicated that a significant direct-contact human health hazard was not expected to exist due to reported concentrations of these organics, and these chemicals were not selected as COPCs.

Substituted benzenes and phenols were also tentatively identified in leachate. Caprolactam, a solvent for polymers used in the manufacture of synthetic fibers, was tentatively identified in leachate.

2.1.7 Air

Because of difficulties with the air sampling program, involving placement of the monitors (especially the first round upwind monitors), sampling time and flow rate, and failure of a pump, the air results were determined not to be satisfactory for a full quantitative baseline risk assessment. Therefore, the summary given here, although it involves comparison to risk-based concentrations, should not be construed as a quantitative risk assessment. The purpose of this discussion is to indicate whether the data suggest a potential air problem that may warrant further investigation.

Organic contaminants were detected in both "upwind" and "downwind" samples. Eight of the nineteen compounds detected had reported maximum concentrations downwind that were less than or approximately equal to the maximum upwind concentrations.

Reported air concentrations were compared to risk-based concentrations. The RBCs were based on the following exposure assumptions:

Residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days per

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year, divided i ͻ lifetime segments of 6 years at 15 kg body weight, inhaliṛ 2 m³ of air per day, and 24 years at 70 kg, inhaling 20 m³/ (30 years of adulthood for noncarcinogens).

Using thesᵢ ᵢssumptions, the RBCs were calculated at target risks of Hazard Quotient (HQ) = 0.1 (one-tenth the no-effects dose) and cancer risk = 1E-6 (probability of excess cancer cases 1 in 1,000,000). Calculation of HQs and estimated cancer risks is discussed in detail in Section 4.1.

Both "upwind" and "downwind" concentrations exceeded RBCs for methylene chloride, carbon disulfide, chloroform, trichloroethene, and benzene. Downwind concentrations exceeded RBCs for carbon tetrachloride and toluene. The widespread detection of VOCs in the air samples and the possibility for the presence of chemicals at unacceptable risk levels in air makes it impossible to rule out air as a potentially significant exposure pathway at thiₛ time.

2.2 Representative Concentrations

Actions at Superfund sites are based on an estimate of the Reasonable Maximum Exposure (RME) expected to occur under current and future land use (USEPA, 1989). For chemical concentrations, the RME may be estimated by using the 95 percent upper confidence limit (UCL) on the mean of a sample set (USEPA, 1989). The 95 percent UCL is calculated as follows:

For data that are normally distributed, the UCL = $x + ts/(n^{0.5})$, where x = the arithmetic mean of the sample set, t = the student's t value (found in statistical tables), s = the standard deviation of the data set, and n = the number of samples.

For data that are lognormal, the UCL = $\exp(x + 0.5s^2 + sH/(n-1)^{0.5})$, where x = mean of the natural logs of the data, s = the standard deviation of the natural logs of the data, H = the H-statistic (found in reference tables), and n = the number of samples.

Both t and H are chosen at the 95% confidence level. The determination of whether the data are normal or lognormal may be made by plotting the concentration vs. the frequency of observations at that concentration, with a bell-shaped curve typically indicating normal data, while a skewed curve usually indicates lognormal data. Alternatively, the Wilks-Shapiro (W-test) may be used.

Representative concentrations were calculated for all COPCs where possible. UCLs could not be calculated for small data sets, including evaluations for most surface water and sediment

locations, and residential wells, where fewer than five samples were available. For such data sets, the representative concentration was the maximum positive concentration.

Data quality played a role in determining which values were included in calculating the 95% UCL. The following assumptions were used:

Data qualified "R" (rejected) were not used. They were also not included when totaling the number of samples in the set. (n).

Data qualified "B" (attributed to blank contamination) were not used. They were also not included when totaling the number of samples in the set (n). At the Bush Valley site, as indicated in the RI report, Region III conventions were not followed with respect to the use of a "B" qualifier. These results can usually be identified as those qualified "U" but without the "<" symbol that indicates the result is a non-detect with reported detection limit.

Data qualified "J", "K", or "L" (estimated or biased high or low) were included as reported. Data without qualifiers were also included as reported.

Detection limits (noted by "U", "UJ", or "UL" qualifiers) were divided in half and included as part of the sample set where there was at least one positive detection for that chemical in that medium.

For duplicate samples, the maximum result of the duplicate pair was used.

Split samples were not included in the data set, but extraordinary split results were evaluated separately.

Where 95% UCLs exceeded the maximum positive concentration for that chemical in that medium, the maximum positive concentration was used instead as the representative concentration.

Representative concentrations are shown for COPCs in the various media in the following tables:

Milton well: Table 1A
Fleet well: Table 2A
Washington well: Table 3B
Stream sediment: Table 5B
Marsh sediment: Tables 6B and 6C
Surface soil: Tables 7B and 7C
SW-7: Table 8A
SD-2: Table 11A

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SD-7: Table 12A
SD-9: Table 14B
Leachate: Tables 16B and 16C
Monitoring wells: Tables 17B, 17C, 17D, and 26
Subsurface soil: Table 18B

They are also summarized for the entire site in Table 33.

3.0 EXPOSURE PATHWAYS

3.1 Receptors

Several factors determine what receptors may be exposed to the COPCs. For a landfill in a residential area, it is expected that residents could trespass onto the site and be exposed to surface soil, sediment, and leachate. Additionally, the land could be considered as the site of future residences. Access is unrestricted to off-site surface water and sediment areas, and it is anticipated that local residents could be exposed to these areas also. Residential wells were sampled, and adults and children living at each of these houses would be the potential receptors of concern for those wells. Groundwater as measured by monitoring wells is also treated as a potential source of contamination, assuming that potable wells could be installed in the future. A maximum exposure in that case would involve a well being installed in the center of the plume.

Estimating RME is not only a conservative approach that will help insure that risk estimations and any actions taken at the site would be protective for the majority of the population, but also can be useful for ruling out areas where even RME exposures would not result in unacceptable risks.

At this site, the decision was made to use the most conservative receptor, a resident who spends some years of both childhood and adulthood in the area, for exposure scenarios. Risks to onsite workers and trespassers would all be less than the resident's exposure.

3.2 Estimating Exposure

Exposure estimations are calculated for each receptor and each medium. The equations used for these calculations are presented below.

3.2.1 Soil

Exposures from direct contact with soil can occur via incidental ingestion of soil and dermal contact. Fugitive dust emissions and emissions of volatile organics from surface soils

may contribute to inhalation exposure, although these pathways are usually much less significant than ingestion and dermal exposure.

Incidental ingestion of soil is estimated as follows:

$$D = (C \times IR \times EF \times ED \times ABS \times Fi \times CF) / (BW \times AT)$$

D = Dose of chemical (mg/kg/day)
C = Concentration of chemical in soil (mg/kg)
IR = Soil ingestion rate (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ABS = Absorption fraction
Fi = Fraction ingested from contaminated source
CF = Conversion factor (kg soil/mg soil: 1e-6)
BW = Body weight (kg)
AT = Averaging time (days)

(USEPA, 1989)

The inputs and assumptions for this equation are presented in Table 19.

Dermal exposure is assessed as follows:

$$D = (C \times SA \times ABS \times AF \times EF \times ED \times CF) / (BW \times AT)$$

D = Dose of chemical (mg/kg/day)
C = Concentration of chemical in soil (mg/kg)
ABS = Absorption fraction
SA = Skin surface are available for contact (cm^2)
AF = Soil-to-skin adherence factor (mg/cm^2)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (kg soil/mg soil: 1e-6)
BW = Body weight (kg)
AT = Averaging time (days)

(USEPA, 1989)

The inputs and assumptions for this equation are shown in Table 19. For those media with non-cadmium metals only as COPCs, dermal absorption of these metals from soil was assumed to be virtually not detectible, and the dermal pathway was not quantitatively evaluated.

For surface soil, the concentrations of volatile contaminants did not warrant full-scale modeling and risk assessment of inhalation exposure. Such exposure would be expected to be negligible at the reported concentrations, and

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ingestion and dermal exposure would contribute the bulk of the risk.

Exposure from fugitive dust emissions can be estimated by estimating first the rate of dust and contaminant emission from the site and then relating this to the exposure rate for the receptors. For sites considered to have unlimited erosion potential (generally sites with small soil particle size and low vegetative cover), emission factors can be estimated as follows:

$$E10 = (0.036) \times (1-V) \times (U/Ut)^3 \times F(x)$$

E10 = PM10 emission factor (g/m^2 hr)
V = Vegetative cover fraction
U = Mean annual wind speed (m/sec)
Ut = Threshold value of wind speed at 7 m (m/sec)
F(x) = Function based on x = 0.886 x Ut/U

The Bush Valley site was considered to have limited erosion potential, considering the particle size (median approximately 0.99 mm) and the vegetative cover (approximately 80%, estimated during EPA site visit). For sites with limited erosion potential, emission factors can be estimated as follows:

$$E10 = [0.695 \times f \times P(U+) \times (1-V)] / (PE/50)^2$$

E10 = PM10 emission factor (mg/m^2 hr)
V = Vegetative cover fraction
f = Disturbance frequency (1/month)
U+ = Fastest mile of wind (m/sec)
P(U+) = Erosion potential (g/m^2)
PE = Thornwaite's precipitation/evaporation index

$$P(U+) = 6.7 \ (U+ - Ut) \quad \text{if } U+ \geq Ut$$
$$\qquad\quad = 0 \qquad\qquad\qquad \text{if } U+ < Ut$$

$$Ut \ / \ U^* = (1/0.4) \ \ln \ (z/z0)$$

Ut = Wind speed at height z (m/sec)
z = Height above surface (cm)
z0 = Roughness height (cm)
U* = Friction velocity (m/sec)

From the emission factors, the emission rates can be estimated as follows:

$$R10 = a \times E10 \times A$$

R10 = Emission rate of contaminant (mg/hr)
a = Mass fraction of contaminant
A = Source extent (m^2)

(Cowherd, 1985)

The annual average air concentrations to receptors 50 meters from the landfill can be estimated using a screening air dispersion model (USEPA, 1992a). The model is described in more detail in Appendix B. Exposure may then be estimated:

$$D = (X \times IR \times EF \times ET \times ED \times AF) / (BW \times AT)$$

D = Exposure dose (mg/kg/day)
X = Respirable concentration (mg/m^3)
IR = Inhalation rate (m^3/hr)
EF = Exposure frequency (days/yr)
ET = Exposure time (hrs/day)
ED = Exposure duration (yrs)
AF = Fraction via exposure route (0.125 for respiration and 0.625 for ingestion of inhaled particles)
BW = Body weight (kg)
AT = Averaging time (days)

(Cowherd, 1985)

The inputs for the fugitive dust emissions model are shown in Appendix B, which includes the calculations for this model.

3.2.2 Sediment

Exposure to sediments were calculated using the same equations as those used to assess soil exposure. Conservative scenarios were used for some sediments, which assumed that residents would come in contact with these unrestricted-access sediments at the same rate at which they would soil in their own yards. This scenario was applied to "non-covered" sediment, which consisted of marsh sediment, basin sediment, and the drainage ditch/tributary sample SD-2. These areas, though reported to be covered by water at certain times, appear to be dry more often (see sample description logs).

For other sediments (stream and tributary SD-7), exposure was assumed to be possible for a wading scenario. Water depths were reported to be two feet or less, (more often approximately one foot) over at least two rounds of sampling, making wading

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more appropriate than swimming. The input parameters are shown on Table 20. The wading exposure scenario was similar to swimming, but the surface area of the body exposed to the media was generally less.

Fugitive dust and volatile emissions are not considered to be factors in sediment exposure, because the sediments are usually well hydrated and are often covered by water or other liquid.

3.2.3 Groundwater

When groundwater is used by human receptors, there are generally three routes of exposure: ingestion, dermal exposure, and inhalation. The greatest exposures are assumed to occur from the activities of drinking and bathing or showering.

Ingestion exposure is estimated as follows:

$$D = (C \times IR \times ED \times EF) / BW \times AT$$

D = Oral dose (mg/kg/day)
C = Concentration of chemical in water (mg/L)
IR = Ingestion rate (L/day)
ED. = Exposure duration (yrs)
EF = Exposure frequency (days/year)
BW = Body weight (kg)
AT = Averaging time (days)

(USEPA, 1989)

The inputs and assumptions for this equation are shown in Table 21.

Dermal exposure to water is estimated as follows:

$$DAD = (DA \times EF \times ED \times A) / (BW \times AT)$$

DAD = Dermally absorbed dose (mg/kg/day)
DA = Dose absorbed per unit area (mg/cm^2)
ED = Exposure duration (yrs)
EF = Exposure frequency (days/year)
A = Skin surface area available for contact (cm^2)
BW = Body weight (kg)
AT = Averaging time (days)

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The term DA is calculated as follows:

For inorganics, $DA = Kp \times C \times t \times CF$

DA = Dermally absorbed dose (mg/cm^2)
Kp = Permeability coefficient from water (cm/hr)
C = Concentration of chemical in water (mg/L)
t = Duration of exposure event (hrs)
CF = Conversion factor (L/cm^2: 1e-3)

For organics, $DA = 2 \times CF \times Kp \times C \times SQRT(6 \times TAU \times t/pi)$ if $t<t*$;
$DA = Kp \times C \times CF \times [t/(1+B) + (2 \times TAU \times ((1+3B)/(1+B)]$ if $t>t*$.

DA = Dermally absorbed dose (mg/cm^2)
Kp = Permeability coefficient from water (cm/hr)
C = Concentration of chemical in water (mg/L)
t = Duration of exposure event (hrs)
CF = Conversion factor (L/cm^3: 1e-3)
TAU = Lag time (hrs)
B = Partitioning constant
$t*$ = Time (hrs)

(USEPA, 1992b)

The inputs and assumptions for these equations are shown in Table 21.

Inhalation exposure through showering is generally assumed to occur for adults only and is estimated as follows:

$DI = D \times EF \times ED / AT$

DI = Inhalation dose (mg/kg/day)
D = Inhalation dose (mg/kg/shower)
EF = Exposure frequency (showers/yr)
ED = Exposure duration (yrs)
AT = Averaging time (days)

The term D is estimated as follows:

$D = [(VR \times S) / (BW \times Ra \times CF)] \times Q$

D = Inhalation dose (mg/kg/shower)
VR = Inhalation rate (L/min)
S = Indoor VOC generation rate (ug/m^3/min)
BW = Body weight (kg)
Ra = Rate of air exchange (1/min)
CF = Conversion factor (ug L /mg/m^3)

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The term Q is calculated:

$$Q = Ds + [(exp(-Ra \times Dt))/Ra] - [(exp(Ra \times (Ds-Dt)))/Ra]$$

Ds = Duration of shower (min)
Dt = Total time in shower room (min)
Ra = Rate of air exchange (1/min)

The term S is estimated as follows:

$$S = Cwd \times FR / SV$$

S = Indoor VOC generation rate ($ug/m^3/min$)
Cwd = Concentration leaving water droplet (ug/L)
FR = Shower flow rate (L/min)
SV = Shower room air volume (m^3)

The term Cwd is calculated:

$$Cwd = C \times CF \times (1-exp[(-KaL \times ts)/60d])$$

Cwd = Concentration leaving water droplet after time ts (ug/L)
C = Concentration in water (mg/L)
CF = Conversion factor (ug/mg: 1000)
KaL = Adjusted overall mass transfer coefficient (cm/hr)
ts = Shower droplet time (sec)
d = Shower droplet diameter (mm)

The term KaL is calculated:

$$KaL = KL / SQRT [(T1 \times uS)/(Ts \times ul)]$$

KaL = Adjusted overall mass transfer coefficient (cm/hr)
KL = Mass transfer coefficient (cm/hr)
T1 = Calibration water temperature of KL (K)
Ts = Shower water temperature (K)
ul = Water viscosity at T1 (centipoise)
uS = Water viscosity at Ts (centipoise)

KL is calculated as follows:

$$KL = 1/[(1/kl) + ((R \times T)/(H \times kg))]$$

KL = Mass transfer coefficient (cm/hr)
R = Gas constant ($atm\ m^3/mol/K$: 8.2e-5)
T = Absolute temperature (K: 293)
H = Henry's Law constant ($atm\ m^3/mol$)
kg = Gas-film mass transfer coefficient (cm/hr)
kl = Liquid-film mass transfer coefficient (cm/hr)

The terms kg and kl are calculated:

$$kg = kH \times SQRT(MWH/MW)$$

$$kl = kC \times SQRT(MWC/MW)$$

kg = Gas-film mass transfer coefficient (cm/hr)
kl = Liquid-film mass transfer coefficient (cm/hr)
kH = kg for water (cm/hr: 3000)
kC = kl for carbon dioxide (cm/hr: 20)
MWH = Molecular weight of water (g/mol: 18)
MWC = Molecular weight of carbon dioxide (g/mol: 44)
MW = Molecular weight of contaminant (g/mol)

(Foster and Chrostowski, 1987)

The inputs and assumptions for these equations are shown in Table 21. For showering exposure, the amount volatilized and available for inhalation exposure was subtracted from the water concentration to give the water concentration available for dermal contact.

Details on the derivation of these equations can be found in the source documents.

3.2.4 Surface Water

Surface water exposure needed only to be quantitatively assessed for the tributary in the marsh, SW-7. A wading scenario was considered appropriate, as described in Section 3.2.2. Therefore, the incidental ingestion and dermal exposure routes would be applicable. The equations used for such exposure are the same used to evaluate ingestion and dermal exposure to groundwater. However, the inputs vary and are shown on Table 22.

3.2.5 Leachate

Leachate seeps are as available as surface soil, when present, but consist of a liquid medium for contact. The equations used to assess dermal and ingestion contact with leachate were therefore the same as for such exposure to other aqueous media (see Section 3.2.3), but the inputs were unique. Exposure was considered to occur for only part of the year (four months), since the leachate is reportedly not present year-round. It was assumed that a person's hands, arms, and feet could come in contact with leachate, and that incidental ingestion might occur for approximately 1 mL (approximately 15-20 drops) of leachate per site visit. The inputs for leachate exposure are presented on Table 23.

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3.2.6 Air

As discussed in Section 2.1.7, a quantitative assessment was not performed for air.

4.0 RISK CHARACTERIZATION

4.1 Toxicological Parameters

Once exposure has been estimated in terms of a dose for each receptor, further assessment must be done to determine the risk associated with that dose. This is commonly done with the use of dose-response parameters.

Dose-response parameters are based on scientific studies. They attempt to correlate a given dose with its effect on a receptor. Noncarcinogenic (non-cancer) effects are generally assumed to have a threshold; that is, a level below which exposure can occur without adverse effects. Carcinogenic (cancer-causing) effects are assumed by EPA to have no threshold; that is, any exposure may potentially cause the cellular changes that lead to uncontrolled cell proliferation. Therefore, the two effects, carcinogenic and noncarcinogenic, are evaluated differently.

The dose-response parameters for the COPCs at the Bush Valley site are shown in Table 31. The following hierarchy was followed in selecting these numbers: parameters from USEPA's Integrated Risk Information System (IRIS), parameters from Health Effects Assessment Summary Tables (HEAST), numbers withdrawn from IRIS or HEAST but not yet substituted, numbers from USEPA's Environmental Criteria and Assessment Office (ECAO), numbers from other sources. Section 5.0 includes further discussion of the sources of these numbers and the uncertainty associated with them.

This section addresses the quantitative toxicity of the COPCs. Appendix C includes Toxicological Profiles for each COPC, which contain descriptions of the properties and potential effects of the COPCs.

4.1.1 Noncarcinogenic Dose-Response Parameters

Concentrations of chemicals at which no adverse effects have been observed, or which were the lowest levels at which adverse effects were observed, may be used to estimate a Reference Dose (RfD) for human exposure. The No-Observed-Adverse-Effects-Levels (NOAELs) or Lowest-Observed-Adverse-Effects-Levels (LOAELs) are typically reported from animal data. Other experimental factors, such as the route of administration of the chemical, may

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contribute to difficulties comparing these data to human exposures. Therefore, EPA develops RfDs for human exposure by multiplying the NOAEL or LOAEL by uncertainty factors and modifying factors. The uncertainty factors are applied to account for variation in the general population, extrapolation from animal data to humans, extrapolation from short-term studies to assessing chronic exposure, differences between NOAELs vs. LOAELs, and any other sources of uncertainty. RfDs are available for ingestion and inhalation exposures. At this time, dermal doses are assessed by comparison to oral RfDs. (USEPA, 1989)

To evaluate human noncarcinogenic risk, the exposure dose is divided by the RfD. If the dose is less than the RfD, this quotient, referred to as the Hazard Quotient (HQ), will be less than 1, and adverse effects would not be anticipated. Because RfDs are set below expected toxic doses, it is difficult to determine at what dose toxicity would be expected to occur. Therefore, although exceedance of RfDs does not necessarily mean that toxic effects will be expected, it is prudent for exposures to result in HQs less than 1.

When more than one chemical is present in the medium of exposure, the combined effects of these chemicals must be considered. Chemicals may act synergistically, where the combined effect is much greater than would be expected when each of their effects is considered individually. They may act antagonistically, where the combined effect is less than would be expected when considering the chemicals individually. Chemicals may also act additively, where the combined effect is equal to the sum of the individual effects. With the present state of knowledge, chemicals in mixtures are assumed to act additively unless there is evidence to the contrary. Therefore, HQs may be added for a total Hazard Index (HI). When the chemicals act on the same target organs via similar mechanisms, it is also desirable for the HI to be less than 1. Therefore, for all HIs greater than 1, an assessment of the mechanisms of toxicity will be made to determine whether an unacceptable risk exists from a combination of chemicals.

RfDs have not been developed for all chemicals. Where they are unavailable, substitute values may be used. For example, a provisional allowable daily intake (ADI) may be estimated using the Layton method, which involves multiplying animal data (usually an LD50, or dose lethal to 50 percent of an experimental population) by a conservative factor (Layton, 1987). For carcinogens, noncarcinogenic effects usually occur at much higher levels than unacceptable carcinogenic risks. In such cases, where the RfD is not available, only carcinogenic effects were assessed.

No RfD has been established for lead. Recent research

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indicates that effects such as lowering of IQ may be associated
with lower blood-lead levels than was formerly believed. As of
yet, no "no-effects" or threshold level has been established for
lead. Therefore, an alternate method for assessing lead has been
developed. The UBK model, developed by USEPA, is designed for
that purpose. The model estimates the total lead uptake in
humans that results from diet, inhalation and ingestion of soil,
dust, water, and paint, and predicts a blood lead level based
upon the total lead uptake. The current versions of this model
estimate lead uptake and blood lead levels in children ages 0-6
years; such children are considered to be the most sensitive
receptors of lead exposure. (USEPA, 1991)

4.1.2 Carcinogenic Dose-Response Parameters

       EPA assigns a "weight-of-evidence" to carcinogens to
evaluate the likelihood that the agent is a human carcinogen.
The weight-of-evidence classifications are defined below:

Group A   Human carcinogen
Group B   Probable human carcinogen; B1 indicates that limited
           human data are available; B2 indicates that there is
           sufficient evidence in animals and inadequate or no
           evidence in humans
Group C   Possible human carcinogen
Group D   Not classifiable as to human carcinogenicity
Group E   Evidence of noncarcinogenicity for humans

       For the purposes of this risk assessment, carcinogenic
effects were assessed for Groups A, B, and C carcinogens.

       The parameter that relates exposure dose to carcinogenic
response is the slope factor. The slope factor is used in risk
assessments to estimate an upper-bound lifetime probability of an
individual developing cancer as a result of exposure to a
carcinogen. Slope factors are derived from scientific study
data, to which a variety of mathematical models may be applied.
For each slope factor, the Integrated Risk Information System
(IRIS) database includes a summary of the information used to
derive that chemical's slope factor.

       To estimate carcinogenic risk, the following equation is
used:

       $CR = 1 - exp(-CSF \times D)$

       CR = Estimated cancer risk
       CSF = Cancer slope factor (1/mg/kg/day)
       D = Exposure dose (mg/kg/day)

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4.1.3 Other Parameters and Criteria

For drinking water, in addition to estimations of risk as described above, comparisons to drinking water criteria may be made. Under the Safe Drinking Water Act, public water suppliers are required to meet National Primary Drinking Water Regulations (NPDWRs), which may take the form of Maximum Contaminant Levels (MCLs) or Action Levels. For the purposes of Superfund risk assessments, chemical concentrations may be compared to these criteria to see whether the water would satisfy the requirements of a public water supply.

This is not a risk estimation method, since MCLs are based on both human health information and available technology. In some cases, MCLs may be well below levels expected to be associated with significant human health risks. In other cases, there may be evidence that MCLs may not be as protective as desired, but the regulations have not been changed yet because of the lengthy process involved in changing these numbers or because no cost-effective technology currently exists for treatment of the chemical in water. However, MCLs may be important because they may be determined to be ARARs.

MCL Goals (MCLGs) are not required to be met by public water supplies. They are health-based numbers, and MCLs are set as close to MCLGs as possible. For known and suspected human carcinogens, the MCLGs are set at zero. Non-zero MCLGs may be determined to be ARARs.

Secondary MCLs (SMCLs) are not health-based. They are designed to prevent unpleasant aesthetic effects in water such as offensive taste or odor, corrosivity or staining of plumbing fixtures.

The individual data evaluation tables for the different areas of groundwater show comparisons of the data to MCLs, MCLGs, and SMCLs.

4.1.4 Adjustment of Dose-Response Parameters

In accordance with USEPA, 1989, Appendix A, the dose-response parameters had to be adjusted when the estimated dose was dermally abosrbed, but the original parameter was based on oral intake. This was done by adjusting the orally administered parameter by the oral absorption percentage (preferably for the same route, vehicle, and species as the critical study on which the parameter was based) to give an absorbed parameter. The following absorption factors were obtained from USEPA IRIS and ECAO:

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Arsenic: 95%
1,2-Dichloroethene: 100%
Nickel: 4.3%
Tetrachloroethene: 100%
Vinyl chloride: 100%
Beryllium: 1%
Manganese: 3-4% from food, 100% from water
Cadmium: 5% from water, 2.5% from food

All other absorption factors for this adjustment were assumed to be 100% if no other number was available. As can be seen from the factors for other volatile compounds, this is expected to be realistic for volatile compounds, and less so for semi-volatiles, pesticides, and metals.

4.2 Toxicity Assessment

This section presents the results of the risk calculations. The calculations are presented in Appendices A and B. For qualitative descriptions of the COPCs, the Toxicological Profiles in Appendix C may be consulted. The risks for each COPC and each medium are summarized in Tables 27 and 28, and total risks are summarized in Table 34.

4.2.1 Surface Soil

Residential direct contact with surface soil would result in an estimated HI of approximately 0.08 for adults or 0.8 for children if the arsenic split result were included and approximately 0.07 for adults and 0.6 for children without the split result. These HIs are less than 1.0. Significant noncarcinogenic impacts are not indicated for this pathway. The estimated excess cancer risks would be approximately 1E-5 (including arsenic) or 4E-6 (not including arsenic). These risks fall within EPA's target risk range of 1E-4 to 1E-6. Chromium is the main contributor to noncancer risk, and arsenic, when included, is the major contributor to carcinogenic risk.

Fugitive dust emissions to current nearby residents from surface soil were estimated. The HI for a resident was less than 1 (approximately 0.1 for adults, 0.3 for children), and the excess cancer risk was estimated at 1.3E-6, due entirely to chromium.

It should be noted that because total chromium was measured, the percentage of the chromium that is hexavalent is unknown. Because hexavalent chromium is more toxic, the chromium was conservatively assumed to be hexavalent. However, chromium in soil is more likely to be trivalent. Trivalent chromium is less toxic, less soluble, and less mobile than hexavalent chromium.

4.2.2 Subsurface Soil

Because soil borings were taken at different depths, it was not considered appropriate to assess sampled subsoil as one large layer that could someday be available for contact. Instead, the two on-site borings with the highest COPC concentrations, GM5 and GM8, were assessed. As previously discussed, the assessment was performed for a hypothetical resident exposure. Workers coming into contact with this soil via excavation or future trespassers if the soil were to become available for contact would have less exposure (and thus lower risk) than the potential residents.

The HIs for residents exposed to sample GM5 soil would be less than 1, indicating that adverse noncarcinogenic impacts would not be expected. The estimated cancer risk for such residents exposed to this soil would be approximately 7E-6, with the majority of the risk due to ingestion during childhood, especially from beryllium.

The HIs for residents exposed to sample GM8 soil would be less than 1, indicating that adverse noncarcinogenic impacts would not be expected. The estimated cancer risk for such residents exposed to this soil would be approximately 1E-5, with the majority of the risk due to ingestion during childhood. Beryllium and Aroclor 1254 were the major contributors to the carcinogenic risk.

4.2.3 Monitoring Wells

4.2.3.1 Area 1

For potential future residents exposed to the representative concentrations of the COPCs in the southern wells, the HIs would be 16.9 for adults, and 37.3 for children if split data are not considered, and 17.4 for adults and 38.4 for children if split data are included. This is primarily due to manganese, but other significant contributors (individual HIs > 1) include trichloroethene and tetrachloroethene. A combination of VOCs not listed above, which act upon the same target organs, would also result in a total HI above 1, due to the inhalation risks from 1,2-dichloroethane and 1,2-dichloropropane. If split data are considered, the same chemicals are notable, with the addition of arsenic and cadmium (individual HIs > 1).

The excess cancer risks for potential future residents for the southern wells are estimated at approximately 9E-4 (without split data) or 1E-3 (with split data). This is primarily due to vinyl chloride, 1,2-dichloroethane, and tetrachloroethene, all of whose individual cancer risks exceed 1E-4. Chemicals whose individual cancer risks exceed 1E-5 include arsenic, beryllium,

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1,2-dichloropropane, and trichloroethene. Chemicals whose individual cancer risks exceed 1E-6 include benzene and 1,4-dichlorobenzene. If split data are considered, the arsenic risks would exceed 1E-4, and the heptachlor epoxide risks would be approximately 1E-6.

It is apparent that, if this water were to be used at the reported concentrations by residents, potential noncancer effects could not be ruled out because of manganese, possibly arsenic, and VOCs singly and in combination. The range of estimated cancer risks and the chemicals contributing to those risks are described above, and the overall estimated cancer risk exceeds 1E-4.

4.2.3.2 Area 2

For potential future residents exposed to the representative concentrations of the COPCs in the northern wells, the HI is estimated at approximately 41.9 for adults and 95.2 for children. This is virtually entirely due to manganese; without manganese, the total HIs would be less than 1.

The excess cancer risk for potential future residents for the northern wells is estimated at approximately 3.5E-4. This is primarily due to beryllium and vinyl chloride, whose individual cancer risks exceed 1E-4. Chemicals whose individual cancer risks exceed 1E-5 include 1,2-dichloroethane. Chemicals whose individual cancer risks exceed 1E-6 include alpha-hexachlorocyclohexane.

It is apparent that, if this water were to be used at the reported concentrations by residents, potential noncancer effects could not be ruled out because of manganese. The range of estimated cancer risks and the chemicals contributing to those risks are described above, and the overall estimated cancer risk exceeds 1E-4.

4.2.3.3 Well GM1US

If the upper sand well were used by potential future residents, the estimated HI would be approximately 25 for adults and 59.1 for children. This is due primarily to manganese, nickel, and tetrachloroethene, all of whose individual HIs exceed 1.

The estimated total excess cancer risk for potential future residents using this water is approximately 2E-4. Half of this risk is due to tetrachloroethene, whose individual cancer risk is approximately 1E-4. The cancer risk for beryllium exceeds 1E-5, and the cancer risks for trichloroethene and benzene exceed 1E-6, contributing the other 1E-4 to the total risk.

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It is apparent that, if this water were to be used at the reported concentrations by residents, potential noncancer effects could not be ruled out because of manganese, nickel, and tetrachloroethene. The range of estimated cancer risks and the chemicals contributing to those risks are described above, and the overall estimated cancer risk exceeds 1E-4.

4.2.3.4 MCLs

As previously discussed, comparisons of groundwater data to MCLs may be useful. Although MCLs are not strictly risk-based, they may be determined to be ARARs. They are the standards with which public water suppliers must comply, and are therefore also useful in showing whether the water would be acceptable for a public water supply under the Safe Drinking Water Act.

Tables 17 and 17A present MCLs for contaminants found in the on-site monitoring wells. It can be seen that, for the contaminants for which MCLs have been promulgated, one cadmium result in an intended upgradient well (GM1LSS), one nickel result in an intended upgradient well (GM1LSS), at least one vinyl chloride result in both Areas 1 and 2, at least one 1,2-dichloroethane result in both Areas 1 and 2, and at least one result of 1,2-dichloropropane, trichloroethene, tetrachloroethene, and benzene in Area 1 exceed MCLs.

Reported concentrations of tetrachloroethene, trichloroethene, and nickel in GM1US also exceed MCLs.

4.2.4 Residential Wells

4.2.4.1 Milton Well

For residents consuming water from the Milton well (if such exposure were to occur), the HIs would be less than 1. Based on this estimation, adverse noncarcinogenic human health hazards are not indicated. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. The COPC for this well was manganese. No MCL has been promulgated for manganese at this time.

4.2.4.2 Fleet Well

For residents consuming water from the Fleet well (if such exposure were to occur), the HIs would be less than 1. Based on this estimation, adverse noncarcinogenic human health hazards are not indicated. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. The COPC for this well was manganese.

Lead was detected in the split sample only at 5.2 ug/l. The

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lead result was assessed using the UBK model. First, the model was run with default parameters (see Appendix A). One of the default parameters is a lead-in-drinking-water concentration of 4 ug/l. Running the model with the default parameters results in estimated blood-lead levels of 2.98 to 3.3 ug/dL for children ages 0-7.

The model was then run with a lead concentration in drinking water of 5.2 ug/l, the value reported in the Fleet well. All other parameters remained the same, so that the contribution from the different lead concentration alone could be seen. The resulting blood-lead levels ranged from 3.07 to 3.34 ug/dL, a negligible increase.

Blood lead levels of 20-40 ug/dL have been associated with changes in enzymes associated with red blood cells. At 40-50 ug/dL, anemia and peripheral neuropathy may be observed. Above 50 ug/dL, brain dysfunction and encephalopathy are possible (Doull, 1986). Recent studies have indicated that subtle effects on intellectual development in children may occur at blood lead levels less than 10 ug/dL; consequently, it is considered desirable to minimize lead exposure.

According to this model, the Fleet well water would contribute less than 0.5 ug/dL to the blood lead of children consuming it, assuming the split results were accepted as real.

No MCL has been promulgated for manganese at this time. The lead concentration was below the Action Level of 15 ug/l that has been promulgated for public water supplies under the Safe Drinking Water Act.

4.2.4.3 Washington Well

For residents consuming water from the Washington well (if such exposure were to occur), the child's HI would be greater than 1, due to the reported concentration of manganese. The ingestion route contributed the bulk of the risk. Above the HI, potential noncarcinogenic effects can no longer be ruled out. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater.

It should be noted that manganese is a common element for which typical dietary intakes up to 10 mg/day have been reported. Recent studies, which were used to set the RfD for manganese, suggest that high levels of manganese in drinking water may be associated with Parkinson-like effects on the nervous system. However, the concentration of manganese in the Washington well is below the concentration range considered to have no effect under that study. The critical study also assumes a difference in bioavailability between manganese in food and manganese in water,

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an assumption that has been questioned by some experts. It has also been stated that children may be less susceptible to manganese than adults.

Uncertainty becomes important when dealing with manganese in drinking water. Section 5.0 should also be consulted for facts relevant to the interpretation of the risks due to manganese.

No MCL has been promulgated for manganese at this time.

4.2.5 Surface Water

As seen in Section 2.1.4, the chemicals in the basin, intermittent stream/drainage ditch, and stream surface water were of sufficiently low concentrations that they were not expected to contribute significantly to human health risk.

A quantitative risk assessment was therefore only performed for the tributary originating in the marsh (SW-7).

For residents wading in this tributary, the HIs would be less than 1. Based on this estimation, adverse noncarcinogenic human health hazards are not indicated for direct contact of this type with this surface water. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. The COPC for this location was manganese.

4.2.6 Sediment

As seen in Section 2.1.5, the chemicals in the basin sediment SD-8 and were of sufficiently low concentrations that they were not expected to contribute significantly to human health risk.

Quantitative risk assessments were therefore performed for the stream sediment, basin sediment SD-9, intermittent stream/drainage ditch sediment (SD-2), the tributary originating in the marsh (SD-7), marsh sediment in Area 1, and marsh sediment in Area 2.

4.2.6.1 Stream Sediment

Because beryllium in the split sample was the only COPC for downstream stream sediment, dermal exposure of this metal from soil was considered to be virtually nonexistent. Therefore, only ingestion exposure was quantified.

For residents wading in this tributary, the HIs would be several orders of magnitude less than 1. Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not

indicated. The estimated carcinogenic risk was approximately 5E-8.

4.2.6.2 Basin Sediment SD-9

Because the COPCs for this sediment were metals, dermal exposure from soil was considered to be virtually nonexistent. Therefore, only ingestion exposure was quantified.

Because this sediment is not always covered by water, it was assumed that this medium could be available for contact as much as surface soil. For hypothetical residential exposure, the HI would be less than 1 (approximately 0.4 for children and 0.04 for adults). Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

The estimated cancer risk would be approximately 2E-5, primarily due to childhood ingestion exposure to arsenic. It should be noted that these risks are based on split sample results only.

4.2.6.3 Intermittent Stream/Drainage Ditch Sediment (SD-2)

Because the COPCs for this sediment were metals, dermal exposure from soil was considered to be virtually nonexistent. Therefore, only ingestion exposure was quantified.

Because this sediment is not always covered by water, it was assumed that this medium could be available for contact as much as surface soil. For hypothetical residential exposure, the HI would be less than 1 (approximately 0.3 for children and 0.04 for adults). Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

The estimated cancer risk would be approximately 1E-5, primarily due to childhood ingestion exposure to arsenic. Beryllium also contributed about one-third of the total carcinogenic risk.

4.2.6.4 Tributary Originating in Marsh (SD-7)

Because the COPCs for this sediment were metals, dermal exposure from soil was considered to be virtually nonexistent. Therefore, only ingestion exposure was quantified.

For residents wading in this tributary, the HIs would be less than 1. Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

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The estimated carcinogenic risk for such contact with this sediment was approximately 3E-7.

4.2.6.5 Marsh Sediment, Area 1

For residential direct contact with marsh sediment, the HI would be less than 1 (approximately 0.3 for children and 0.04 for adults). Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

The estimated carcinogenic risk was approximately 1E-5, due almost equally to arsenic and beryllium.

4.2.6.6 Marsh Sediment, Area 2

Marsh sediment was evaluated both with and without split data. For residential direct contact with this sediment, the HI would be less than 1 whether split data were included or not (approximately 0.5 for children and 0.05 for adults without split data, approximately 0.6 for children and 0.06 for adults with split data). Based on these estimations, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

The estimated cancer risks were approximately 1E-5 (without split data) to 2E-5 (with split data), due almost equally to arsenic and beryllium.

4.2.7 Leachate

As previously described, an exposure scenario had to be "custom-made" for the unusual situation of exposure to liquid leachate. Neither a drinking nor a swimming scenario were strictly appropriate. Instead, direct contact for a duration similar to that of the wading scenario, with a contact frequency similar to that of soil exposure but adjusted for the amount of time leachate seeps are reported to be actually flowing, was assumed. It was assumed that incidental ingestion would be much less than that for swimming or wading, and the estimate used was 1 mL of leachate (approximately 15-20 drops) per exposure.

The estimated HIs were less than 1 (approximately 0.3 for children and 0.09 for adults). Based on this estimation, adverse noncarcinogenic human health hazards due to direct contact of this type with this sediment were not indicated.

Lead was detected in leachate at 217 ug/l. The lead result was assessed using the UBK model. First, the model was run with default parameters (see Appendix A). One of the default parameters is a lead-in-drinking-water concentration of 4 ug/l.

Running the model with the default parameters results in estimated blood-lead levels of 2.98 to 3.3 ug/dL for children ages 0-7.

The model was then run with a lead concentration "in fountain water" of 217 ug/l. The fountain option simply allows the modeler to introduce another source of lead ingestion from a liquid, besides the major source, which is the regular drinking water. In this case, because the amount of leachate ingested was assumed to be 1 mL in a day, the percent ingested from that source was 0.05 (rounded to 0.1). Two options then remained for the handling of the 4 ug/l drinking water default source: assuming that the first-draw lead would decline to 1 ug/l, or assuming that the lead concentration would remain 4 ug/l. Both options were used for comparison's sake. All other parameters remained the same, so that the contribution from the leachate lead concentration alone could be seen. The resulting blood-lead levels ranged from 2.88 to 3.26 ug/dL (assuming decline of first-draw lead concentration) or from 2.99 to 3.3 ug/dL (assuming a steady concentration of 4 ug/l). There was essentially no increase.

No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. The COPCs for this location were manganese and lead.

4.2.8 Air

Air contamination was discussed in Section 2.1.7.

4.3 Total Risks

It is possible that a single receptor could be exposed to more than one contaminated medium, therefore increasing his or her total risk. In considering additive risks across pathways, it was considered reasonable that one person might be exposed to one source of drinking water, one source of soil or non-covered sediment, and one "intermittent-exposure" (wading or leachate) contaminated medium. Tables 29 and 30 display individual pathways for which additive risks were considered.

For the monitoring wells and Washington well, Hazard Indices already exceeded 1 for each of these water sources in and of itself. Therefore, it was not necessary to add other pathways to these sources.

The potential drinking water sources were the Fleet and Milton wells; the potential soil/sediment sources were surface soil, marsh sediment Area 1, marsh sediment Area 2, sediment SD-9, sediment SD-2, subsoil SB-5, and subsoil SB-8. The potential intermittent-exposure sources were stream sediment, surface water

and sediment from SW-7/SD-7, and leachate.

Total cancer risks from these additions were in or below the range 1E-4 to 1E-6.

No combination of adult HIs resulted in a total HI greater than 1. The child's total Hazard Index from surface soil direct contact and fugitive dust inhalation was approximately 0.9 to 1.1, depending upon whether split data are used. Other combinations that resulted in child HIs greater than 1 were residential well water plus Area 2 marsh sediment with or without split data (HI approximately 1) plus SW-7/SD-7 or leachate. For these combinations, it is necessary to determine which chemicals cause the HI to exceed 1, and to determine whether these chemicals would actually affect the same target organs and act similarly to make the assumption of additive effects valid.

Because HIs are based on RfDs, and RfDs are based on a critical sensitive effect, these effects were the ones considered. Because the HIs are so near 1 (that is, near the RfD), this approach is appropriate.

The surface soil direct contact noncancer risk is driven by ingestion of chromium and arsenic for split data and ingestion of chromium if split data are not included. The fugitive dust emissions noncancer risk is driven by inhalation of chromium. The oral RfD for arsenic is based on hyperpigmentation, keratosis, and vascular effects on the skin. The oral RfD for chromium is based on a no-effects level. However, renal tubular necrosis is a potential effect of chromium toxicity via the oral route. The inhalation RfD was based on corrosive effects of a chromium compound on the nasal septum. Hence, it can be seen that the mechanisms involved in the toxicity of these chemicals are dissimilar, and adding the HIs for these pathways may be misleading. If HIs for direct contact with soil are added to the residential well water HIs or to the leachate or SW-7/SD-7 HI, the total HI would again exceed 1 (HIs approximately 1.1 to 1.3). However, the HIs for residential well water, SW-7/SD-7, and leachate are due to ingestion of manganese. The RfD for manganese is based on Parkinson-like effects on the nervous system. Again, the mechanisms involved are dissimilar, and adding the HIs could be misleading.

HIs for both of the marsh sediment areas are driven by ingestion of chromium, arsenic, and vanadium. Aluminum is also a contributor in Area 2. The vanadium dose is based on a no-effects dose, but vanadium may affect the gastrointestinal, renal, and nervous systems. The oral RfD for aluminum is based on phosphate depletion leading to osteomalacia. The toxicity of chromium and arsenic via the oral route have been discussed above. Combining these effects with the oral toxicity of

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manganese (from well water and leachate or SW-7/SD-7, whose HIs are driven by manganese) leads to some uncertainty as both manganese and vanadium may affect the nervous system, and both chromium and vanadium may cause renal effects. However, the combination of manganese and vanadium HQs results in a "neurological HI" of approximately 0.9, and the combination of chromium and vanadium HQs results in a "renal HI" of approximately 0.2. Therefore, adding HIs for these pathways may be misleading. Addition of the two sediment routes is additionally conservative because it assuems that for 7 days per year, the child's soil/sediment intake would be doubled.

In conclusion, none of the combinations of pathways for which HIs are less than 1 (that is, not including monitoring wells and the Washington well) give a clear indication of potentially significant noncarcinogenic hazards. Some combination HIs are at or just above 1, but the chemicals involved do not appear to affect the same target organs at these concentrations, such that adding HIs may be misleading. It should also be noted that RfDs are deliberately intended to represent no-effects doses rather than toxic doses. The uncertainties described in Section 5.0 are also important for interpretation of these results.

5.0 UNCERTAINTY ANALYSIS

Uncertainty associated with the assessment of risk may be associated with exposure estimation, toxicity assessment, and in risk characterization. The policy of the USEPA is to be protective of human health and the environment. In accordance with this policy, exposure estimates and the parameters used in the characterization of the exposures at the Bush Valley Landfill are of a conservative nature whenever possible. These conservative parameters are designed to insure that all estimates are protective and that all sensitive subpopulations are considered. Some of these exposure parameters may be overestimates of the actual exposures experienced by receptors at the site.

Monitoring well exposures may be overestimates of risk by virtue of the fact that risk characterization is usually conducted with the assumption that due to future development or plume migration, receptors will come into contact with the monitoring well plume or groundwater of similar quality. Monitoring wells are not in use for drinking purposes at this time. In fact, the three residential wells sampled for the RI are also reported to be no longer used for drinking water as public water supplies are becoming more accessible in the neighborhood, although the existing private wells may continue to be used for gardening and car washing purposes.

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Attempts were made to use site-specific information wherever possible, but even these parameters (such as site area and frequency of leachate flow) are estimates. The exposure estimates also assumed that 100 percent of a person's residential soil or groundwater contact would come from the site or drainage pathways of the site. An adult worker's or an occasional trespasser's exposure to soil and sediment would be expected to be less than the resident's. In cases where site-specific numbers were not available, default parameters were used. The use of default parameters may lead to an overestimation of risk, since these values are conservative for the purpose of protecting sensitive receptors in risk evaluation. There are also uncertainties associated with chemical-specific input parameters such as permeability constants.

Agency guidance assumes that the concentrations of contaminants identified will remain the same over time. Since the contaminant concentrations may decrease over time, the exposures of receptors and subsequent risks calculated may be overestimates for future exposure. One exception to this is the potential for degradation of chlorinated ethenes to vinyl chloride. Since vinyl chloride is a more potent carcinogen than the other chlorinated ethenes, future increase in vinyl chloride concentrations could result in an increase in future risk.

Exposure of receptors due to the contaminants in the Washington well may be overestimated due not only to the question of actual usage but also to the quality of the groundwater as impacted by the levels of manganese. Manganese is known to affect the aesthetic qualities of groundwater, making it less desirable for consumption due to adverse effects upon the color, odor, and taste at concentrations above 50 ug/l. (Staining of laundry and plumbing fixtures may also occur.)

Uncertainty associated with toxicity characterization may be due to factors including extrapolation from subchronic to chronic data, intraspecies extrapolation, interspecies variability, lack of certain types of data, data limitations, and other relevant modifying factors. All of these factors are taken into account when evaluating the toxicity of the contaminants in question. Toxicity factors may be based upon cases such as the extrapolation of data obtained from animal studies in which short-term exposure to very high concentrations of contaminants produced some carcinogenic effects to possible human effects produced by low-dose long-term exposures.

The evaluation of the uncertainty associated with toxicity also includes an assessment of the certainty with respect to RfD values and the safety factors built into the toxicity values used for the evaluation of contaminants. It should be noted that in applying the Agency's RfD methodology, arguments may be made for

various RfD values within a factor of 2 or 3 of the current RfD value. Additionally, the RfD computation methodology derives a number with inherent uncertainty that may span an order of magnitude. The IRIS database includes information related to the uncertainty factors and the confidence in the RfD values for a given contaminant. Section 4.2.4.3 includes a brief discussion about manganese in drinking water at concentrations less than 200 ug/l.

Aluminum (oral RfD), benzene (inhalation RfD), chlorobenzene (inhalation RfD), chromium (inhalation RfD), 1,2-dichloroethane (inhalation RfD), tetrachloroethene (oral and inhalation CSF), and trichloroethene (oral RfD and CSF, inhalation CSF) have no toxicity values listed for them in IRIS or the Health Effects Assessment Summary Tables (HEAST). Interim toxicity values have been used for these constituents [either withdrawn IRIS or HEAST values, numbers from the Environmental Criteria and Assessment Office (ECAO), or, in the case of aluminum, a 1987 OHEA document]. The oral CSF for arsenic was based on exposure to water, and the application of this number to exposure via soil may not be strictly appropriate but is used as the best available information.

Chromium was assumed to be hexavalent, since the analytical techniques did not differentiate between trivalent and hexavalent chromium and hexavalent is generally more toxic. However, this in all probability results in overestimate of risks from chromium, especially for soil, where the chromium is more likely to be trivalent.

Some exposures could not be assessed at all because of lack of any sort of toxicity criteria (inhalation exposure to 1,2-dichloroethene; adult exposure to lead). USEPA ECAO determined that the information is inadequate for a numerical assessment of 1,2-dichloroethene's inhalation toxicity at this time. The adult exposure to lead is not expected to be as significant an omission because the child receptor, which was assessed, is considered to be more sensitive.

There was additional uncertainty associated with the adjustment of oral dose-response parameters for dermally absorbed doses. As noted, when absorption factors were not available, the chemical was assumed to be 100% absorbed during the RfD or CSF study. While this is likely to be realistic for volatile compounds, the assumption could be underprotective for chemicals absorbed less than 100%.

COPCs were selected based on exceedance of RBCs. In actuality, chemicals such as arsenic, manganese, and beryllium are fairly common as naturally occurring metals in the environment. It is difficult to separate possible natural risks

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from potentially site-related risks in the cases of these metals; therefore, the total risk, as per USEPA, 1989, has been presented.

Uncertainty associated with the characterization of risk is related to the uncertainty of the exposure and toxicity characterizations. It is noted that risk is a function of the intake of a contaminant as based on the exposure scenario and the toxicity of the contaminant to which the receptor has been exposed. It is acknowledged that the uncertainty associated with the use of the default exposure parameters are conservative and therefore probably overestimate the actual exposure (except in the case of 1,2-dichloroethene, above). The uncertainty associated with RfDs and other toxicity data values is based upon the methodology used to derive the data values, the quality of the data derived from the various studies used to assess the toxicity of the contaminant, and the margins of safety built into these values.

These risks also do not take into account whether the chemical is expected to be site-related or naturally occurring. In accordance with USEPA, 1989, total risks were assessed. However, wherever attribution to the site was questionable (an issue that is especially important for metals), this was noted in the discussion of the COPC selection. If decisions whether to take action revolve around such determinations, input from hydrogeological experts could be necessary to identify clearly upgradient locations. As noted in the discussion on air contamination, current data are inadequate to quantitatively assess risk or to separate site-related from non-site-related detections. There was also uncertainty in identifying upgradient groundwater, as previously discussed.

Detection limits for antimony in groundwater in the first two sampling rounds were above RBCs, and the antimony results for the third round were rejected during data validation. Reported quantitation limits for many VOCs in groundwater were also above RBCs. Therefore, there is uncertainty as to whether all these chemicals would have been detected if present at significant concentrations. This does not appear to be a major problem for VOCs in monitoring wells, since the laboratory did see and report detections below the Contract-Required Quantitation Limit (CRQL). Also, since one-half the CRQL was used for organic non-detects, a high QL results in a more conservative estimate. However, this is not applicable for the antimony results (since inorganic non-detects are reported at the Sample Quantitation Limit). For VOCs in residential wells, it is likely that the laboratory could detect concentrations below the CRQL, but because the true SQL is unknown, it cannot be determined whether all QLs were sufficient for the detection of chemicals at levels of concern in such small sample sets (2-3 samples for each residential well).

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No special subpopulations (other than children, which are considered to be part of almost every residential population) were identified in the vicinity of the site. Subpopulations such as workers and trespassers would be expected to have a lower risk than that estimated for residents in this report.

The main body of this report contains risk estimations based on the reasonable maximum exposure (RME), in accordance with current USEPA guidance. It is the risk based on RME exposure on which management decisions are generally based. In order to provide some quantitative indication of the uncertainty associated with the risks, a central tendency estimation is also included herein. Generally speaking, the RME approach may be seen as the attempt to quantify risks associated with "high-end" (but not worst-case) exposure, while the central tendency approach attempts to quantify "average" exposure.

For the purposes of this uncertainty assessment, the following pathways with total HIs greater than 1 or total cancer risks greater than 1E-6 were assessed: residential exposure to the Washington well, Area 1 monitoring wells, Area 2 monitoring wells, Well GM1US, Area 1 marsh sediment, Area 2 marsh sediment, surface soil, sediment SD-2, sediment SD-9, subsoil SB-5, and subsoil SB-8.

Input parameters that were chosen at the 95th percentile for RME exposure (exposure duration, water intake) were changed to the 50th percentile or the reported average. Therefore, the water ingestion rate was changed to 1.4 L/day for adults and 0.7 L/day for children, and exposure duration was changed to 7 years for adults and 2 years for children for a total of 9 years. Other exposure parameters, such as body weight and surface area, were already 50th percentile or average values and were not changed. Chemical concentrations were changed to the arithmetic mean (unless the maximum positive concentration was lower because of the use of 1/2 detection limits); the sample median concentrations were generally found to be very close to the arithmetic means. Also, for this assessment, duplicate results were averaged instead of selecting the higher of the two, as in the RME estimate.

The results of the central tendency assessment are summarized on Table 35, where they are compared with the RME values. It can be seen that, while the risks are lower as expected, there are no HIs that would be less than 1 for the central tendency exposure when the RME exposure was greater than 1 except for the child's exposure to the Washington well. There is greater difference in the cancer risks, with the risks for MW Area 2 and Well GM1US dropping from greater than 1E-4 to greater than 1E-5, surface soil without split data dropping from greater than 1E-6 to less than 1E-6. All other cancer risks that were

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within the 1E-4 to 1E-6 range for RME exposure remained within that range for central tendency exposure, although several dropped an order of magnitude. The estimated cancer risks for MW Area 1 were greater than 1E-4 whether assessed using RME or central tendency assumptions.

6.0 SUMMARY

Soil, groundwater, surface water, sediment, air, and leachate were considered to be the media of potential concern with regard to quantitative risk assessment. Because of the site's location in a residential area and the fact that future uses of relevant media are unknown, the receptors were assumed to be residents, divided into lifetime segments of exposure during both childhood and adulthood. Exposures to the receptors were estimated, and the exposure doses related to toxicity factors to estimate non-cancer and cancer risks. Blood-lead levels for lead exposure were also estimated.

Soil and groundwater samples that were designed to be upgradient or background were often not clearly free of site influence. Therefore, there is some ambiguity when determining the relationship of on-site and off-site concentrations, especially for metals, for these media.

The air sampling results were not deemed adequate for a full quantitative baseline risk assessment. Both "upwind" and "downwind" concentrations exceeded RBCs for methylene chloride, carbon disulfide, chloroform, trichloroethene, and benzene. Downwind concentrations exceeded RBCs for carbon tetrachloride and toluene. The widespread detection of VOCs in the air samples and the possibility for the presence of chemicals at unacceptable risk levels in air makes it impossible to rule out air as a potentially significant exposure pathway at this time.

In surface soil, arsenic, beryllium, chromium, vanadium, and manganese were selected as COPCs. Fugitive dust emissions for chromium and manganese were evaluated. Each of these exposure pathways results in an HI less than 1 and cancer risks between 1E-4 and 1E-6. Beryllium and arsenic (in the split sample only) were the major contributors to the cancer risks.

Beryllium, cadmium, and Aroclor 1254 were selected as COPCs in subsurface soil. The HIs for residents exposed to sample GM5 soil would be less than 1. The estimated cancer risk would be approximately 7E-6, with the majority of the risk due to beryllium.

The HIs for residents exposed to sample GM8 soil would be less than 1. The estimated cancer risk would be approximately 1E-5, with the majority of the risk due to beryllium and Aroclor

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Area 1 monitoring well COPCs included arsenic, beryllium,
chromium, manganese, vinyl chloride, 1,2-dichloroethene, 1,2-
dichloroethane, 1,2-dichloropropane, benzene, tetrachloroethene,
chlorobenzene, 1,4-dichlorobenzene, trichloroethene, heptachlor
epoxide (split sample only), and cadmium (split sample only).
If this water were to be used at the reported concentrations by
residents, potential noncancer effects could not be ruled out (HI
> 1) because of manganese, possibly arsenic, and VOCs singly and
in combination. The range of estimated cancer risks and the
chemicals contributing to those risks are described in Section
4.2.3.1, and the overall estimated cancer risk exceeds 1E-4.

COPCs in Area 2 monitoring wells were beryllium, manganese,
1,2-dichloroethane, vinyl chloride, and alpha-HCH. If this water
were to be used at the reported concentrations by residents,
potential noncancer effects could not be ruled out (HI > 1)
because of manganese. The range of estimated cancer risks and
the chemicals contributing to those risks are described in
Section 4.2.3.2, and the overall estimated cancer risk exceeds
1E-4.

While the metals were generally found at higher
concentrations in on-site than intended upgradient well samples,
some of the intended background samples also had potentially
significant concentrations: beryllium, cadmium, manganese, and
nickel in GM1LSS, and manganese in GM7 and GM9.

Well GM1US, an on-site upper-sand well originally intended
to represent upgradient water quality, was evaluated for the
COPCs beryllium, manganese, nickel, benzene, tetrachloroethene,
and trichloroethene. If this water were to be used at the
reported concentrations by residents, potential noncancer effects
could not be ruled out (HI > 1) because of manganese, nickel, and
tetrachloroethene. The range of estimated cancer risks and the
chemicals contributing to those risks are described in Section
4.2.3.3, and the overall estimated cancer risk exceeds 1E-4.

For the contaminants for which MCLs have been promulgated,
one cadmium result in GM1LSS, one nickel result in GM1LSS, at
least one vinyl chloride result in both Areas 1 and 2, at least
one 1,2-dichloroethane result in both Areas 1 and 2, and at least
one result of 1,2-dichloropropane, trichloroethene,
tetrachloroethene, and benzene in Area 1 exceeded MCLs. Reported
concentrations of tetrachloroethene, trichloroethene, and nickel
in GM1US also exceeded MCLs.

Manganese was selected as a COPC for both the Milton and
Fleet wells. The split result also revealed lead in one sample
from the Fleet well. For residents consuming water from the

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Milton or Fleet wells (if such exposure were to occur), the HIs would be less than 1. No carcinogens were detected in either well at concentrations associated with the 1E-6 cancer risk level or greater. The Fleet well water would be exected to contribute less than 0.5 ug/dL to the blood lead of children consuming it, a negligible increase, assuming the split results were accepted as real.

For child residents consuming water from the Washington well (if such exposure were to occur), the HI would be greater than 1, due to the reported concentration of manganese. The ingestion route contributed the bulk of the risk. Above the HI, potential noncarcinogenic effects can no longer be ruled out. However, uncertainty plays a major role in the interpretation of this result (see Sections 4.2.4.3 and 5.0). No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater.

The chemicals in the basin, intermittent stream/drainage ditch, and stream surface water were of sufficiently low concentrations that they were not expected to contribute significantly to human health risk. A quantitative risk assessment was therefore only performed for the tributary originating in the marsh (SW-7). For residents wading in this tributary, the HIs would be less than 1. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. The COPC for this location was manganese.

The chemicals in the basin sediment SD-8 were of sufficiently low concentrations that they were not expected to contribute significantly to human health risk. Quantitative risk assessments were therefore performed for the stream sediment, basin sediment SD-9, intermittent stream/drainage ditch sediment (SD-2), the tributary originating in the marsh (SD-7), marsh sediment in Area 1, and marsh sediment in Area 2.

Beryllium (in the split sample only) was the only COPC for downstream stream sediment. For residents wading in the stream, the HIs would be several orders of magnitude less than 1. The estimated carcinogenic risk was approximately 5E-8.

Arsenic, beryllium, and vanadium (all from split samples only) were the COPCs for basin sediment SD-9. For hypothetical residential exposure, the HIs would be less than 1. The estimated cancer risk would be approximately 2E-5, primarily due to childhood ingestion exposure to arsenic.

Arsenic, beryllium, and manganese were the COPCs for intermittent stream/drainage ditch sediment SD-2. For hypothetical residential exposure, the HIs would be less than 1. The estimated cancer risk would be approximately 1E-5, primarily

due to arsenic and beryllium.

Aluminum, arsenic, beryllium, chromium, manganese, and vanadium were the COPCs for the tributary originating in the marsh (SD-7). For residents wading in this tributary, the HIs would be less than 1. The estimated carcinogenic risk for such contact with this sediment was approximately 3E-7.

Arsenic, beryllium, chromium, and vanadium were the COPCs for marsh sediment in Area 1. For residential direct contact with marsh sediment, the HIs would be less than 1. The estimated carcinogenic risk was approximately 1E-5, due almost equally to arsenic and beryllium.

Aluminum, arsenic, beryllium, chromium, and vanadium were the COPCs for marsh sediment in Area 2. For residential direct contact with this sediment, the HIs would be less than 1 whether split data were included or not. The estimated cancer risks were approximately 1E-5 (without split data) to 2E-5 (with split data), due to arsenic and beryllium.

The COPCs evaluated for leachate were manganese and lead. The estimated HIs were less than 1. No carcinogens were detected at concentrations associated with the 1E-6 cancer risk level or greater. According to the UBK model, exposure to lead in leachate is not expected to result in measurable blood-lead increases.

None of the combinations of pathways for which HIs are less than 1 (that is, not including monitoring wells and the Washington well) give a clear indication of potentially significant additive noncarcinogenic hazards. In a few cases, combination HIs are at or just above 1, but the chemicals involved do not appear to affect the same target organs, such that adding HIs may be misleading. Total cancer risks for combinations of pathways for which cancer risks are less than 1E-4 (that is, not including monitoring wells) fell in or below the range from 1E-4 to 1E-6.

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TABLE 1
INORGANIC DATA EVALUATION FOR THE MILTON WELL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	MCL (ug/l)	10^-6/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC?
Barium	2/2	10.8J	18.1J	2,000	260	
Calcium	2/2	1300J	3640J			
Cobalt	1/2	8.3J	8.3J			
Copper	1/2	12J	12J	1300[4]	140	
Iron	1/2	98.6J	98.6J	300[5]		
Magnesium	2/2	957J	2120J			
Manganese	2/2	6.5J	23.2	50[5]	18	YES
Mercury	1/2	0.34	0.34	2	1.1	
Nickel	1/2	23.9J	23.9J	100	73	
Potassium	2/2	288J	394J			
Sodium	2/2	3790J	7390	5000[5]		
Zinc	1/2	20.5	20.5		1100	

NOTES:

[1] Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and maximum detected concentrations above the detection limit.

[4] MCLG

[5] SMCL

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TABLE 1A
CONTAMINANT OF POTENTIAL CONCERN
IN MILTON WELL
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (ug/l)
Manganese	23.2

[1] Representative concentration is equivalent to the maximum positive concentration.

TABLE 2
INORGANIC DATA EVALUATION FOR THE FLEET WELL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	MCL (ug/l)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC
Barium	2/2	10.1J	16.3J	2,000	260	
Calcium	2/2	1430J	3020J			
Copper	1/2	8.4J	8.4J	1300[4]	140	YES
Iron	2/2	112	141	300[5]		
Lead[7]	0/2	--	--	15[6]		
Magnesium	2/2	986J	1960J			
Manganese	2/2	4.2J	22.2	50[5]	18	YES
Mercury	1/2	0.34	0.34	2	1.1	
Nickel	1/2	19.8J	19.8J	100	73	
Potassium	2/2	327J	344J			
Sodium	2/2	4060J	6700			
Zinc	1/2	19.3J	19.3J	5000[5]	1100	

NOTES:

1   Number of times constituent was detected above the detection limit. Sample results
    from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

4   MCLG

5   SMCL

6   Action Level.

7   Lead was detected in split samples only.

--   Not detected.

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TABLE 2A
CONTAMINANTS OF POTENTIAL CONCERN
IN FLEET WELL
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (ug/l)
Lead[2]	5.2
Manganese	22.2

[1] Representative concentration is equivalent to the maximum positive concentration.

[2] Lead was detected in split samples only and received a special evaluation.

TABLE 3
INORGANIC DATA EVALUATION FOR THE WASHINGTON WELL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	MCL (ug/l)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC?
Aluminum	2/2	160J	267	50 to 200[4]	11,000	
Barium	2/2	16.6J	18.2J	2000	260	
Calcium	2/2	4590J	5600			
Iron	2/2	713	909	300[4]		
Magnesium	2/2	2690J	2730J			
Manganese	2/2	89.7	111	50[4]	18	YES
Nickel	1/2	12.3J	12.3J	100	73	
Potassium	2/2	365J	427J			
Sodium	2/2	11,300	12,200			

NOTES:

1   Number of times constituent was detected above the detection limit. Sample results from duplicates
    were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based in number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

4   SMCL

TABLE 3A
ORGANIC DATA EVALUATION FOR THE
WASHINGTON WELL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		MCL	$10^{-6}/\text{HQ} = 0.1$ RISK BASED CONCENTRATION (ug/l)	COPC?
		MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)			
alpha–BHC	1/2	0.0040J	0.0040J		0.013	

NOTES:

1   Number of times constituent was detected above the detection limit. Sample results from
    duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit.

TABLE 3B
CONTAMINANT OF POTENTIAL CONCERN
IN WASHINGTON WELL
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (ug/l)
Manganese	111

[1]   Representative concentration is equivalent to the maximum positive concentration.

TABLE 4
INORGANIC DATA EVALUATION FOR STREAM SURFACE WATER
(TOTAL INORGANICS ONLY)
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION IN SW3, SW4 AND SW6 (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION IN SW3, SW4, SW6 MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	SW1 MAXIMUM[4] (ug/l)	SW5 MAXIMUM[5] (ug/l)	10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (ug/l)	COPC ?
Aluminum	2/6	75.6J	88.9J	153J	<116	940,000	
Barium	6/6	18.9J	21.6J	22.1J	24.5J	22,600	
Calcium	6/6	15,600	19,100	15,700	20,900		
Copper	0/6	--	--	7.1J	--	12,000	
Iron	6/6	254	432	327	162		
Magnesium	6/6	6270	7470	6290	7510J		
Manganese	6/6	37.3	81.1	47.4	39.2	1600	
Potassium	6/6	1930J	2620J	2420J	2690J		
Selenium	1/6	1.0J	1.0J	<1	<1	1600	
Sodium	6/6	8610	10,000	9130J	10,500J		
Zinc	2/6	5.2J	26.5	B	B	97,000	

NOTES:

1   Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent. SW3, SW4, SW6 are downstream locations.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

4   Maximum positive concentration in upstream location SW1.

5   Maximum positive concentration in upstream location SW5.

--   Not detected.

B   Not detected substantially above the level reported in laboratory or field blanks.

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TABLE 4A
ORGANIC DATA EVALUATION FOR STREAM SURFACE WATER
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION IN SW3, SW4 AND SW6 (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION IN SW3, SW4 AND SW6 MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	SW1 MAXIMUM[4] (ug/l)	SW5 MAXIMUM[5] (ug/l)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC?
alpha-BHC	0/6	--	--	0.0049J	--	4	

NOTES:

1   Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent. Locations SW3, SW4, SW6 are downstream locations.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

4   Maximum positive concentration in upstream location SW1.

5   Maximum positive concentration in upstream location SW5.

--   Not detected.

TABLE 5

INORGANIC DATA EVALUATION FOR STREAM SEDIMENT
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION IN SD3, SD4 AND SD6 (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION IN SD3, SD4 AND SD6 MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	SD1 MAXIMUM[4] (mg/kg)	SD5 MAXIMUM[5] (mg/kg)	10^-6/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg)	COPC?
Aluminum	3/3	74	2950J	2370J	1980J	23,000	
Arsenic	1/3	1.0J	1.0J	1.8J	<0.75	2.3[7]	
Barium	1/3	28.4J	28.4J	18.3J	19J	550	
Beryllium[6]	0/3	--	--	0.38J	<0.24	0.15	YES
Calcium	1/3	3140J	3140J	860J	1790J		
Chromium	3/3	6.2	9.1J	13J	10.9J	39	
Cobalt	1/3	4.6J	4.6J	4.5J	3.8J		
Copper	3/3	3.3J	5.1J	4.8J	6.5	290	
Iron	3/3	6550J	7300	9540J	6740J		
Magnesium	3/3	706J	1060J	1120J	848J		
Manganese	3/3	732J	602J	127J	196J	1095[8]	
Nickel	1/3	5.7J	5.7J	8.1J	5.7J	160	
Potassium	3/3	206J	580J	335J	184J		
Vanadium	3/3	8.8J	10.6J	12.3	8.8J	55	
Zinc	1/3	30.8	30.8	31.4	B	2300	
Cyanide	1/3	2.8	2.8	<0.6	<0.62	160	

NOTE:

[1] Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single results using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and Maximum detected concentrations above the detection limit.

[4] Maximum positive concentration in upstream location SD1.

[5] Maximum positive concentration in upstream location SD5.

[6] For downstream samples, beryllium was detected in split samples only.

[7] Based on RfD; see also discussion of arsenic and carcinogenicity.

[8] Based on manganese -- in -- food RfD.

-- Not detected.

B Not detected subtantially above the level reported in laboratory or field blanks.

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TABLE 5A
ORGANIC DATA EVALUATION FOR STREAM SEDIMENT
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION IN SD3, SD4 AND SD6 (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION IN SD3, SD4 AND SD6 MINIMUM[3] (ug/kg)	RANGE OF CONCENTRATION IN SD3, SD4 AND SD6 MINIMUM[3] (ug/kg)	SD1 MAXIMUM[4] (ug/kg)	SD5 MAXIMUM[5] (ug/kg)	10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/kg)	COPC?
1,2–Dichloropropane	0/3	--	--	--	3.00J	9400	

NOTES:

1   Number of times constituent was detected above the detection limit.
    Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentration above the detection limit.
4   Maximum positive concentration in upstream location SD1.
5   Maximum positive concentration in upstream location SD5.

--   Not detected.

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TABLE 5B
CONTAMINANT OF POTENTIAL CONCERN
IN STREAM SEDIMENT
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (mg/kg)
Beryllium	0.34

[1] Representative concentration is equivalent to the maximum positive concentration; a special evaluation was performed for the split sample results.

TABLE 6
INORGANIC DATA EVALUATION FOR MARSH SEDIMENT AREAS 1 AND 2
BUSH VALLEY LANDFILL
(Based on RI Data for First Round Sampling only)

| PARAMETER | MARSH SEDIMENT AREA 1 MSD1 – MSD5 | | | MARSH SEDIMENT AREA 2 MSD6 – MSD9 | | | 10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg) | COPC? | |
	FREQUENCY OF DETECTION (# Detects/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	FREQUENCY OF DETECTION (# Detects/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)		AREA 1	AREA 2
Aluminum	5/5	7330	22,000	3/4	8950	24,800	23,000		YES
Arsenic	5/5	1.4J	2.6J	3/4	2.3	3.1J	2.3[4]	YES	YES
Barium	5/5	31.5J	111	4/4	36.2J	119	550	YES	YES
Beryllium	5/5	0.26J	0.78J	3/4	0.31J	0.96J	0.15		
Chromium	5/5	17.4	46.3	4/4	17.6	45.7	39 (Cr VI)	YES	YES
Cobalt	5/5	6.6J	17.8J	4/4	7.4J	23			
Copper	5/5	9.0	34.0	4/4	10	32.5	290		
Iron	5/5	11,600	32,500	4/4	15,300	37,300			
Lead	4/5	15.3	37.6	2/4	19.8	23.5J			
Magnesium	5/5	1420	4750	4/4	1530	5090			
Manganese	5/5	255J	648J	4/4	219J	961J	1095[5]		
Mercury	--	--	--	1/4	0.19	0.19	2.3		
Nickel	--	--	--	1/4	17.5	17.5	160		
Potassium	5/5	566J	1550	4/4	430J	1320J			
Vanadium	5/5	21	69.1	4/4	28.7	67.6	55		
Zinc	5/5	41.1	117	4/4	81.7	118	2300	YES	YES
Cyanide	1/5	1.3	1.3	3/4	1.2	1.9	160		

NOTES:
1   Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit.
4   Based on RfD for arsenic; see also discussion of arsenic carcinogenicity.
5   Based on manganese – in – food RfD.
--   ...ected.

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| PARAMETER | MARSH SEDIMENT AREA 1 MSD1 – MSD5 | | | MARSH SEDIMENT AREA 2 MSD6 – MSD9 | | | 10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (ug/kg) | COPC? | |
	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/kg)	MAXIMUM[3] (ug/kg)	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/kg)	MAXIMUM[3] (ug/kg)		AREA 1	AREA 2
1,2–Dichloropropane	1/5	4	4	--	--	--	9400		
Di–n–butylphthalate	2/5	110	720	2/4	160	420	780,000		
Fluoranthene	3/5	52	150	--	--	--	310,000		
Pyrene	1/5	120	120	--	--	--	235,000		
Butylbenzylphthalate	--	--	--	2/4	140	650	1,600,000		
Bis(2–ethylhexyl)phthalate	3/5	94	210	2/4	58	180	45,600		
Benzo(B)fluoranthene	4/5	58	310	2/4	58	120	875		

NOTES

1. Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2. Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3. Minimum and maximum detected concentrations above the detection limit.

4. Based on RfD for arsenic; see also discussion of arsenic carcinogenicity.

5. Based on manganese–in–food RfD.

-- Not detected.

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TABLE 6B
CONTAMINANTS OF POTENTIAL CONCERN
FOR MARSH SEDIMENT AREAS 1 AND 2
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION (mg/kg)	
	MARSH SEDIMENT AREA 1[1]	MARSH SEDIMENT AREA 2[2]
Aluminum	--	24,800
Arsenic	2.6	3.1J[3]
Beryllium	0.74	0.96J
Chromium	42.6	45.7
Vanadium	63.4	67.6

NOTES:

[1]   Representative concentration is maximum or UCL from Table 6C.
[2]   Representative concentration is the maximum positive concentration.
[3]   Arsenic in MSD9 (split) was 5.2 mg/kg; special evaluation.

-- Not applicable.

TABLE 6C
STATISTICAL EVALUATION FOR AREA 1 MARSH SEDIMENT COPCs
BUSH VALLEY LANDFILL

COPC	n	LOGNORMAL OR NORMAL DIST. AND ASSOCIATED "W" VALUE[1]	STANDARD DEVIATION	DEGREES OF FREEDOM	$H_{.95}$ (LOGNORMAL)[2] OR $T_{.95}$ (NORMAL)[3] VALUE	NORMAL OR LOGNORMAL UCL (mg/kg)	MAXIMUM VALUE (mg/kg)	MAXIMUM OR UCL VALUE DETERMINATION (mg/kg)
Arsenic	5	W=0.9166; Normal	0.4669	4	T=2.132	2.59	2.6	2.59
Beryllium	5	W=0.9512; Normal	0.1920	4	T=2.132	0.74	0.78	0.74
Chromium	5	W=0.9604; Normal	10.39	4	T=2.132	42.57	46.3	42.57
Vanadium	5	W=0.9680; Normal	17.45	4	T=2.132	63.35	69.1	63.35

NOTES:
[1] W = Shapiro-Wilk statistic. The value listed was determined by computing W using both raw and log transformed data,
then choosing the greater value to determine the data set's most representative distribution.
Distribution significance determined at the alpha = 0.05 quantile based on n (Table A7, Gilbert, 1987).
[2] From Table A12, Gilbert, 1987.
[3] From Table A2, Gilbert, 1987.

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TABLE 7
INORGANIC DATA EVALUATION FOR SURFACE SOILS
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects/# Samples[2])	ONSITE SURFACE SOIL (SUS4 – SUS8) RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	MAXIMUM POSITIVE CONCENTRATION[1] SUS1 (mg/kg)	MAXIMUM POSITIVE CONCENTRATION[1] SUS2 (mg/kg)	MAXIMUM POSITIVE CONCENTRATION[1] SUS3 (mg/kg)	10^{-6}/HQ = 0.1 RISK CONCENTRATION (mg/kg)	COPC?
Aluminum	5/5	5200	13,400	9760	9490	10,700	23,000	
Arsenic[5]	0/5	--	--	B	B	B	2.3[6]	YES
Barium	5/5	30.5J	142	38.2J	51.6	63.8	550	YES
Beryllium	2/5	0.49J	0.53J	<0.25	0.29J	0.43J	0.15	YES
Calcium	5/5	365J	8490	1590	1410	1390		
Chromium	5/5	12.9J	207	19.2	19.5	20.8	39	YES
Cobalt	5/5	3.5J	15	3.6J	10.1J	8.9J		
Copper	5/5	4.9J	19.5	11.4	17.7	18.5	290	
Iron	5/5	1,500	47,000	15,500	18,100	19,700		
Lead	4/5	11.7J	17.5J	28.6J	B	13.1J		
Magnesium	5/5	863J	2500J	1130J	3210	3,350		
Manganese	5/5	257J	83.1J	95.7J	44.1J	46.8J	1095[7]	
Mercury	4/5	0.13	0.25	<0.13	<0.13	0.14	2.3	
Nickel	5/5	5.5J	28.7	5.1J	12.7	12.1	160	
Potassium	5/5	303J	886J	42.1J	1620	1610		
Sodium	5/5	63.7J	746J	79.1J	69.7J	104J		
Vanadium	5/5	19.2	53.7	26.4	32.5	34.2	55	YES
Zinc	5/5	20.1	53	38.6	50.9	58.6	2300	
Cyanide	5/5	0.82	1.5	0.92	0.73	1.9	160	

NOTES:

1   Number of times constituent was detected above the detection limit
    Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit
4   Maximum positive concentration above the sample quantitation limit
5   Detected in split samples only
6   Based arsenic RfD; see also discussion of arsenic carcinogenicity.
7   Based on RfD for manganese in food.
-- Not detected.
B   Not detected substantially above the level reported in laboratory or field blanks.

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TABLE 7A
ORGANIC DATA EVALUATION FOR SURFACE SOILS
BUSH VALLEY LANDFILL

PARAMETER	ONSITE SURFACE SOIL (SUS4 – SUS8)			MAXIMUM POSITIVE CONCENTRATION[4] SUS1 (ug/kg)	MAXIMUM POSITIVE CONCENTRATION[4] SUS2 (ug/kg)	MAXIMUM POSITIVE CONCENTRATION[4] SUS3 (ug/kg)	10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/kg)	COPC ?
	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/kg)	MAXIMUM[3] (ug/kg)					
Acetone	1/5	31.0	31.0	--	--	--	780,000	
Di–n–butylphthalate	1/5	86.0J	86.0J	--	--	100	780,000	
Fluoranthene	1/5	54J	54J	--	--	--	310,000	
Pyrene	1/5	57J	57J	--	--	--	235,000	
Bis(2–ethylhexyl)phthalate	5/5	60.0J	6100	--	160J	--	45,600	
Benzo(b)fluoranthene	1/5	64J	64J	--	--	--	875	

NOTES:

[1] Number of times constituent was detected above the detection limit.

Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and maximum detected concentrations above the detection limit.

[4] Maximum positive concentration above the sample quantitation limit.

-- Not detected.

TABLE 7B
CONTAMINANTS OF POTENTIAL CONCERN
SURFACE SOILS
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION[1] (mg/kg)
Arsenic[2]	3.5L
Beryllium	0.53J
Chromium	207
Manganese[3]	737
Vanadium	52.94

NOTES:

[1] Representative concentration is maximum or UCL from Table 7C.

[2] Detected in split samples only; special evaluation.

[3] For dust emissions only.

TABLE 7C
STATISTICAL EVALUATION FOR SURFACE SOIL COPCs
BUSH VALLEY LANDFILL

COPC	n	LOGNORMAL OR NORMAL DIST. AND ASSOCIATED "W" VALUE[1]	LOG-TRANSFORMED STANDARD DEVIATION	DEGREES OF FREEDOM	H_{05} (LOGNORMAL)[2] OR T_{05} (NORMAL)[3] VALUE	NORMAL OR LOGNORMAL UCL (mg/kg)	MAXIMUM VALUE (mg/kg)	MAXIMUM OR UCL VALUE DETERMINATION (mg/kg)
Arsenic*								
Beryllium	5	W = 0.7671; Lognormal	0.7574	4	H = 4.062	1.388	0.53	0.53
Chromium	5	W = 0.6526; Lognormal[4]	1.164	4	H = 6.001	1689	207	207
Manganese[5]		W = 0.9249; Normal	0.5149	4	T = 2.132	737	831	737
Vanadium	5	W = 0.8756; Lognormal	0.4238	4	H = 2.651	52.94	53.7	52.94

* COPC based on split sample data.

NOTES:

1. W = Shapiro–Wilk statistic. The value listed was determined by computing W using both raw and log transformed data, then choosing the greater value to determine the data set's most representative distribution.
   Distribution significance determined at the alpha = 0.05 quantile based on n (Table A7, Gilbert, 1987).

2. From Table A12, Gilbert, 1987.

3. From Table A2, Gilbert, 1987.

4. The null hypotheses (of a normal and lognormal distribution) are rejected,
   as W is less than the quantile at alpha = 0.05 (or any notable alpha error level) based on n = 5. However, as the W value for a lognormal distribution is greater than the normal W value, the lognormal UCL is assumed to be the most representative, and will be calculated.

5. Selected for dust emissions only.

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TABLE 8
INORGANIC DATA EVALUATION FOR SW7 (Total Inorganics Only)
BUSH VALLEY LANDFILL

| PARAMETER | FREQUENCY OF DETECTION (# Detects[1]/# Samples[2]) | RANGE OF CONCENTRATION | | 10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/l) | COPC? |
		MINIMUM [3] (ug/l)	MAXIMUM [3] (ug/l)		
Aluminum	2/2	126J	337	940,000	
Barium	2/2	30.0J	48.3J	22,600	
Calcium	2/2	20,200	20,200		
Iron	2/2	3960	14,700		
Magnesium	2/2	9800	11,300		
Manganese	2/2	3770	4220	1600	YES
Potassium	2/2	978J	1760J		
Sodium	2/2	23,300	33,600		
Zinc	2/2	3.6J	102	97,000	

NOTES:

1   Number of times constituent was detected above the detection limit.
    Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

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TABLE 8A
CONTAMINANT OF POTENTIAL CONCERN
AT SW7
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (ug/l)
Manganese	4220

[1]   Representative concentration is equivalent to the maximum positive concentration.

TABLE 9
INORGANIC DATA EVALUATION FOR SW8 (Total Inorganics Only)
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/l)	COPC?
		MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)		
Aluminum	1/1	2200	2200	940,000	
Barium	1/1	86.2J	86.2J	22,600	
Calcium	1/1	77,900	77,900		
Chromium	1/1	6.6J	6.6J	1600	
Copper	1/1	5.5J	5.5J	12,000	
Iron	1/1	3750	3750		
Lead	1/1	3.5J	3.5J		
Magnesium	1/1	18,200	18,200		
Manganese	1/1	227	227	1600	
Potassium	1/1	18,700	18,700		
Sodium	1/1	67,600	67,600		

NOTES:

[1] Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and maximum detected concentrations above the detection limit.

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TABLE 9A
ORGANIC DATA EVALUATION FOR SW8
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/l)	COPC?
		MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)		
Carbon Disulfide	1/1	3J	3J	32,000	

NOTES:

1 Number of times constituent was detected above the detection limit.
   Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2 Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3 Minimum and maximum detected concentrations above the detection limit.

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TABLE 10

INORGANIC DATA EVALUATION FOR SW9 (Total Inorganics Only)

BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		$10^{-6}/HQ = 0.1$ RISK CONCENTRATION (ug/l)	COPC?
		MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)		
Aluminum	1/1	2350	2350	940,000	
Barium	1/1	41.5J	41.5J	22,600	
Calcium	1/1	36,800	36,800		
Chromium	1/1	12.2J	12.2J	1600	
Copper	1/1	5.4J	5.4J	12,000	
Iron	1/1	3240	3240		
Lead	1/1	2.3J	2.3J		
Magnesium	1/1	12,400	12,400		
Manganese	1/1	83	83	1600	
Potassium	1/1	4430J	4430J		
Sodium	1/1	30,400	30,400		
Zinc	1/1	57.4J	57.4J	97,000	

NOTES:

1   Number of times constituent was detected above the detection limit.
    Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

TABLE 10A
ORGANIC DATA EVALUATION FOR SW9
BUSH VALLEY LANDFILL

| PARAMETER | FREQUENCY OF DETECTION (# Detects[1]/# Samples[2]) | RANGE OF CONCENTRATION | | 10^{-6}/HQ = 0.1 RISK CONCENTRATION (ug/l) | COPC? |
		MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)		
Carbon Disulfide	1/1	32	32	32,000	

NOTES:

[1] Number of times constituent was detected above the detection limit.
Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and maximum detected concentrations above the detection limit.

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INORGANIC DATA EVALUATION FOR SD2
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg)	COPC?
		MINIMUM [3] (mg/kg)	MAXIMUM [3] (mg/kg)		
Aluminum	1/1	17,800	17,800	23,000	
Arsenic	1/1	3.7J	3.7J	2.3[4]	YES
Barium	1/1	131	131	550	
Beryllium	1/1	0.65J	0.65J	0.15	YES
Calcium	1/1	2870	2870		
Chromium	1/1	30.7	30.7	39	
Cobalt	1/1	18.8	18.8		
Copper	1/1	25	25	290	
Iron	1/1	31,400	31,400		
Lead	1/1	26.1	26.1		
Magnesium	1/1	4030	4030		
Manganese	1/1	1970J	1970J	1095[5]	YES
Potassium	1/1	1340J	1340J		
Vanadium	1/1	46	46	55	

NOTES:

1   Number of times constituent was detected above the detection limit.
    Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit.
4   Based on arsenic Rfd; see also discussion of arsenic carcinogenicity.
5   Based on RfD for manganese in food.

AR302158

TABLE 11A
CONTAMINANTS OF POTENTIAL CONCERN
SAMPLE SD2
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (mg/kg)
Arsenic	3.7J
Beryllium	0.65J
Manganese	1970J

[1]   Representative concentration is equivalent to the maximum positive concentration.

AR302159

TABLE 12
INORGANIC DATA EVALUATION FOR SD7
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	10^{-6}/HQ = 0.1 RISK CONCENTRATION (mg/kg)	COPC ?
Aluminum	1/1	22,500	22,500	23,000	YES
Arsenic	1/1	3.1J	3.1J	2.3[4]	YES
Barium	1/1	136	136	550	
Beryllium	1/1	0.78J	0.78J	0.15	YES
Chromium	1/1	38.8	38.8	39	YES
Cobalt	1/1	20.5J	20.5J		
Copper	1/1	31.1	31.1	290	
Iron	1/1	48,900	48,900		
Lead	1/1	39.7	39.7		
Magnesium	1/1	4320	4320		
Manganese	1/1	1980J	1980J	1095[5]	YES
Potassium	1/1	997J	997J		
Vanadium	1/1	64.5	64.5	55	YES

NOTES:

1. Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2. Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable sample .
3. Minimum and maximum detected concentrations above the detection limit.
4. Based on RfD; see also discussion of arsenic carcinogenicity.
5. Based on RfD for manganese in food.

AR302160

TABLE 12A
CONTAMINANT OF POTENTIAL CONCERN
SAMPLE SD7
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (mg/kg)
Aluminum	22,500
Arsenic	3.1J
Beryllium	0.78J
Chromium	38.8
Manganese	1980J
Vanadium	64.5

[1] Representative concentration is equivalent to the maximum positive concentration.

TABLE 3
INORGANIC DATA EVALUATION FOR SD8
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg)	COPC?
Aluminum	1/1	7120	7120	23,000	
Barium	1/1	29.4J	29.4J	550	
Calcium	1/1	883J	883J		
Chromium	1/1	19.6	19.6	39	
Cobalt	1/1	4.5J	4.5J		
Copper	1/1	9.3	9.3	290	
Iron	1/1	13,900	13,900		
Magnesium	1/1	1090J	1090J		
Manganese	1/1	196J	196J	1095[4]	
Nickel	1/1	6.4J	6.4J	160	
Potassium	1/1	527J	527J		
Sodium	1/1	89.7J	89.7J		
Vanadium	1/1	24.3	24.3	55	
Zinc	1/1	37.3	37.3	2300	
Cyanide	1/1	0.78	0.78	160	

NOTES:

1   Number of times constituent was detected above the detection limit.
     Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit.
4   Based on RfD for manganese in food.

AR302162

TABLE 13A
ORGANIC DATA EVALUATION FOR SD8
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (ug/kg)	COPC?
		MINIMUM [3] (ug/kg)	MAXIMUM [3] (ug/kg)		
Bis-(2ethylhexyl)phthalate	1/1	300J	300J	45,600	

NOTES:

1   Number of times constituent was detected above the detection limit.
     Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3   Minimum and maximum detected concentrations above the detection limit.

TABLE 14
INORGANIC DATA EVALUATION FOR ...
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	MAXIMUM[3] (mg/kg)	10^-6/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg)	COPC?
Aluminum	1/1	12,900	12,900	23,000	
Arsenic[4]	0/1	B	B	2.3[5]	YES
Barium	1/1	68.8	68.8	550	
Beryllium[4]	0/1	--	--	0.15	YES
Calcium	1/1	2300	2300		
Chromium	1/1	31.3	31.3	39	
Cobalt	1/1	8.5J	8.5J		
Copper	1/1	14.2	14.2	290	
Iron	1/1	23,700	23,700		
Lead	1/1	12.9J	12.9J		
Magnesium	1/1	1920	1920		
Manganese	1/1	636J	636J	1095[7]	
Mercury	1/1	0.14	0.14	2.3	
Nickel	1/1	10.5	10.5	160	
Potassium	1/1	683J	683J		
Sodium	1/1	88.4J	88.4J		
Vanadium	1/1	43	43	55	
Zinc	1/1	88.2	88.2	2300	YES[6]
Cyanide	1/1	0.79	0.79	160	

NOTES:
[1] Number of times constituent was detected above the detection limit.
  Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
[3] Minimum and maximum detected concentrations above the detection limit.
[4] Detected in split samples only.
[5] Based on RfD for arsenic; see also discussion of arsenic carcinogenicity.
[6] COPC only according to split data.
[7] Based on RfD for manganese in food.

-- Not detected.
B Not detected substantially above the level reported in laboratory or field blanks

AR302164

TABLE 14A
ORGANIC DATA EVALUATION FOR SD9
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION		10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (ug/kg)	COPC?
		MINIMUM[3] (ug/kg)	MAXIMUM[3] (ug/kg)		
Bis(2–ethylhexyl)phthalate	1/1	130J	130J	85,000	

NOTES:

1   Number of times constituent was detected above the detection limit.
     Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

TABLE 14B
CONTAMINANTS OF POTENTIAL CONCERN
SD9
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (mg/kg)
Arsenic[2]	6.8^3
Beryllium[2]	0.45^3
Vanadium	54.7^3

[1] Representative concentration is equivalent to the maximum positive concentration.
[2] Detected in split samples only.
[3] Based on split data only.

TABLE 15
INORGANIC DATA EVALUATION FOR SW2
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (ug/l)	COPC?
Aluminum	1/1	232	232	940,000	
Barium	1/1	50J	50J	22,600	
Calcium	1/1	25,900	25,900		
Cobalt	1/1	14.7J	14.7J		
Copper	1/1	5.2J	5.2J	12,000	
Iron	1/1	1430	1430		
Lead	1/1	8.2J	8.2J		
Magnesium	1/1	8130	8130		
Manganese	1/1	960	960	1600	
Nickel	1/1	10.5J	10.5J	6400	
Potassium	1/1	5930	5930		
Sodium	1/1	24,600	24,600		

NOTES:

1   Number of times constituent was detected above the detection limit.
     Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

2   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

3   Minimum and maximum detected concentrations above the detection limit.

TABLE 16
INORGANIC DATA EVALUATION FOR LEACHATE
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	RANGE OF CONCENTRATION MAXIMUM[3] (ug/l)	10^{-6}/HQ = 0.1 BASED CONCENTRATION (ug/l)	COPC?
Aluminum	1/6	301	179,000	940,000	
Barium	6/6	68.6J	6880	22,600	
Cadmium	1/6	6.2	6.2	160	
Calcium	6/6	102,000	332,000		
Chromium	5/6	6.6	669J	1600	
Cobalt	5/6	9.8J	248		
Copper	4/6	7.8J	244	12,000	
Iron	6/6	2880	1,340,000		YES
Lead	4/6	3.9J	215J		
Magnesium	6/6	19,400	80,400		
Manganese	6/6	513	10,700	1600	YES
Mercury	1/6	0.22	0.22	97	
Nickel	6/6	11.8J	347	6400	
Potassium	6/6	10,700	99,000		
Silver	1/6	5.3J	5.3J	1600	
Sodium	6/6	24,600	360,000		
Vanadium	4/6	10.9J	421	2260	
Zinc	4/6	11.4J	1250J	97,000	

NOTES:

[1]   Number of times constituent was detected above the detection limit.
     Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
[2]   Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
[3]   Minimum and maximum detected concentrations above the detection limit.

TABLE 16A
ORGANIC DATA EVALUATION FOR LEACHIATE
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION (MIN = MAX) MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC?
VOCs					
Toluene	1/6	2J	2J	64,500	
SVOCs					
1,4-Dichlorobenzene	3/6	2J	6J	1000	
1,2-Dichlorobenzene	1/6	5J	5J	29,000	
4-Methylphenol	1/6	4J	4J	1600	
2,4-Dimethylphenol	1/6	4J	4J	6450	
Naphthalene	4/6	2J	9J	12,900	
2-Methylnaphthalene	1/6	2J	2J		
Diethylphthalate	5/6	1J	4J	260,000	

NOTES:

[1] Number of times constituent was detected above the detection limit.
Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

[2] Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

[3] Minimum and maximum detected concentrations above the detection limit.

AR302169

TABLE 16B
CONTAMINANT OF POTENTIAL CONCERN
IN LEACHATE
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION [1] (ug/l)
Lead	215J
Manganese	10,700

[1] Representative concentration is maximum positive concentration or UCL from Table 16C.

TABLE 16C
STATISTICAL EVALUATION FOR LEACHATE COPCs
BUSH VALLEY LANDFILL

COPC (Total)	n	LOGNORMAL OR NORMAL DIST. AND ASSOCIATED "W" VALUE[1]	LOG-TRANSFORMED STANDARD DEVIATION	DEGREES OF FREEDOM	$H_{0.95}$ (LOGNORMAL)[2] OR $T_{0.95}$ (NORMAL)[3] VALUE	NORMAL OR LOGNORMAL UCL (ug/l)	MAXIMUM VALUE (ug/l)	MAXIMUM OR UCL VALUE DETERMINATION (ug/l)
Lead	6	W = 0.8905; Lognormal	2.316	5	H = 8.339	8.6×10^5	215	215
Manganese	6	W = 0.9073; Lognormal	1.0460	5	H = 8.339	17,871	10,790	10,700

NOTES:
1 W = Shapiro-Wilk statistic. The value listed was determined by computing W using both raw and log transformed data, then choosing the greater value to determine the data set's most representative distribution. Distribution significance determined at the alpha = 0.05 quantile based on n (Table A7, Gilbert, 1987).

2 From Table A12, Gilbert, 1987.

3 From Table A2, Gilbert, 1987.

TABLE 17

INORGANIC DATA EVALUATION MONITORING WELLS/GROUNDWATER AREAS 1 & 2
BUSH VALLEY LANDFILL

PARAMETER	GROUNDWATER AREA 1			GROUNDWATER AREA 2			MAXIMUM POSITIVE CONCENTRATION GM11SS (ug/l)	MAXIMUM POSITIVE CONCENTRATION GM7 (ug/l)	MAXIMUM POSITIVE CONCENTRATION GM9 (ug/l)	MCLs	10^{-6}/HQ = 0.1 RISK BASED CONCENTRATIONS (ug/l)	CORC? AREA 1	CORC? AREA 2
	FREQUENCY OF DETECTION (# Detect/# Samples)	RANGE OF CONCENTRATION MINIMUM (ug/l)	MAXIMUM (ug/l)	FREQUENCY OF DETECTION (# Detect/# Samples)	RANGE OF CONCENTRATION MINIMUM (ug/l)	MAXIMUM (ug/l)							
Aluminum	9/9	246	3830	5/6	15.9J	1560J	1430J	1360	332J	50 – 200[a]	11,000		
Arsenic	3/9	3.2J	4.2J	0/6	--	--	<3	<3	<3	50	0.046	YES	
Barium	9/9	53.2J	173J	6/6	65.1J	93J	73.3J	70.5J	21.8J	2000	260		YES
Beryllium	2/9	1.2J	2.1J	3/6	1.7J	3.3J	2.1J	<1	<1	4	0.019	YES	
Cadmium	0/9	--	--	0/5	--	--	10.5	<5	<5	5	1.5		
Calcium	9/9	16,400	30,700	6/6	17,200	37,700	9470	14,200	3050J			YES	
Chromium	4/9	8.4J	23.9	0/6	--	--	<10	8.8J	<10	100	18	YES	
Cobalt	8/9	17.2J	101	4/6	78.7	187	158	<14	22.9J				
Copper	5/9	7.2J	13.1J	4/6	7.7	18.3J	12.2J	11.1J	10.5J	1300[a]	140		
Iron	9/9	1230	76,400	6/6	2900	105,000	612	24,200	707	300[a]			
Lead	1/9	2.5J	2.5J	0/6	--	--	B	B	<2	15[?]			
Magnesium	9/9	8940	21,300	6/6	7660	17,000	7060	9260	1370J				
Manganese	9/9	431	2820	6/6	4370	8620	243	3780	24.2	50[a]	18	YES	YES
Nickel	5/9	11.2J	21.0J	3/6	29J	54.8	253	<14	49.2	100	73		
Potassium	9/9	1120J	7850	6/6	1160J	2390J	8020	721J	458J				
Sodium	9/9	14,000	44,500	6/6	8650	31,800	24,100	6120	6150				
Vanadium	3/9	11.9J	16.4J	0/6	--	--	12J	<9	<9		26		
Zinc	4/9	6.7	34.9J	1/6	--	--	299	<3	B	5000[a]	1100		

NOTES:

Number of times constituent was detected above the detection limit.

Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.

Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.

Groundwater Area 1 is GM21SS, GM5, and GM44LSS.

Groundwater Area 2 is GM5, GM44, and GM8.

MCLG

Action Level

SMCL

-- Not detected.

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TABLE 17A

ORGANIC DATA EVALUATION FOR MONITORING WELLS/GROUNDWATER AREAS 1 & 2
BUSH VALLEY LANDFILL

PARAMETER	GROUNDWATER AREA 1			GROUNDWATER AREA 2						MCLs	$10^{-6}/1$ Q = 0.1 RISK BASED CONCENTRATION (ug/l)	COPC? AREA 1	COPC? AREA 2
	FREQUENCY OF DETECTION (# Detect/# Samples)	RANGE OF CONCENTRATION		FREQUENCY OF DETECTION (# Detect/# Samples)	RANGE OF CONCENTRATION		MAXIMUM POSITIVE CONCENTRATION GMIL5S (ug/l)	MAXIMUM POSITIVE CONCENTRATION GM7 (ug/l)	MAXIMUM POSITIVE CONCENTRATION GM9 (ug/l)				
		MINIMUM (ug/l)	MAXIMUM (ug/l)		MINIMUM (ug/l)	MAXIMUM (ug/l)							
Vinyl Chloride	5/9	7J	13	1/6	3J	3J	--	--	--	2	0.023	YES	YES
Chloroethane	4/9	4J	13	0/6	--	--	--	--	--		71		
1,1-Dichloroethane	7/9	4J	49	2/6	3J	5J	--	--	--		51	YES	
1,2-Dichloroethene	5/9	3J	8J	0/6	--	--	--	--	--	70(cis) 100(trans)	3.5	YES	YES
1,2-Dichloroethane	9/9	3J	140J	3/6	3J	13J	--	--	--	5	0.15	YES	
1,3-Dichloropropane	6/9	4J	11	0/6	--	--	--	--	--	5	0.2	YES	
Trichloroethene	6/9	3J	52	0/6	--	--	--	--	--	5	2.9	YES	
Benzene	6/9	3J	7J	0/6	--	--	--	--	--	5	0.35	YES	
Tetrachloroethene	4/9	14	56	0/6	--	--	--	--	--	5	1.3	YES	
Chlorobenzene	5/9	4J	8J	0/6	--	--	--	--	--	100	3.9	YES	
1,1,1-Trichloroethane	0/9	--	--	0/6	--	--	--	--	4J	200	130		
Toluene	0/9	--	--	0/6	--	--	--	--	3J	1000	75		
1,4-Dichlorobenzene	7/9	2J	3J	0/6	--	--	--	--	--	75	0.35	YES	
Alpha-BHC	0/9	ND	ND	1/6	0.012J	0.012J	0.0041J	--	--		0.013		YES

NOTES:

1 Number of times constituent was detected above the detection limit.
2 Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
3 Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
4 Maximum and minimum detected concentrations above the detection limit.
5 Groundwater Area 1 is GM2LS5, GM3, and GM4LS5
6 Groundwater Area 2 is GM5, GM6, and GM8
ND - not detected.

TABLE 17B
CONTAMINANT OF POTENTIAL CONCERN
GROUNDWATER AREAS 1 & 2
BUSH VALLEY LANDFILL
(ug/l)

PARAMETER	REPRESENTATIVE CONCENTRATION[1]	
	AREA 1 (ug/l)	AREA 2 (ug/l)
Arsenic	3.51; 5 *	
Beryllium	1.125	2.726
Cadmium	5.8 *	
Chromium	16.16	
Manganese	2588	7450
Vinyl Chloride	10.03	3J
1,2–Dichloroethene	5.90	
1,2–Dichloroethane	75.51	12.61
1,2–Dichloropropane	9.53	
Benzene	5.32	
Tetrachloroethene	51.22	
Chlorobenzene	6.77	
1,4–Dichlorobenzene	6.39	
Trichloroethene	52	
Heptachlor epoxide	0.005*	
Alpha–BHC		0.012J

[1] Representative concentration is equivalent to the maximum positive concentrations or UCL from Tables 17C and 17D.

* Split data; special evaluation.

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TABLE 17C
STATISTICAL EVALUATION FOR AREA 1 GROUNDWATER COPCs
BUSH VALLEY LANDFILL

COPC (Total)	n	LOGNORMAL OR NORMAL DIST. AND ASSOCIATED "W" VALUE[1]	LOG-TRANSFORMED OR NORMAL STANDARD DEVIATION	DEGREES OF FREEDOM	$H_{.99}$ (LOGNORMAL)[2] OR $T_{.95}$ (NORMAL)[3] VALUE	NORMAL OR LOGNORMAL UCL (ug/l)	MAXIMUM VALUE (ug/l)	MAXIMUM OR UCL VALUE DETERMINATION (ug/l)
Arsenic	9	W=0.8313; Lognormal	0.5632	8	H=2.368	3.51	4.2	3.51
Beryllium	9	W=0.5709; Lognormal[4]	0.5283	8	H=2.220	1.13	2.1	1.125
Chromium	9	W=0.9197; Lognormal	0.6904	8	H=2.532	16.16	23.9	16.16
Manganese	9	W=0.9392; Lognormal	0.6405	8	H=2.368	2588	2820	2588
Vinyl Chloride	9	W=0.8288; Normal	3.279	8	T=1.860	10.03	13.0	10.03
1,2-Dichloroethene	9	W=0.8677; Lognormal	0.2634	8	H=1.977	5.90	8.0	5.90
1,2-Dichloroethane	9	W=0.8924; Normal	45.27	8	T=1.860	75.51	140	75.51
1,2-Dichloropropane	9	W=0.8672; Lognormal	0.3522	8	H=2.089	9.53	11.0	9.53
Benzene	6	W=0.6679; Lognormal[4]	0.3423	5	H=2.125	5.32	7.0	5.32
Tetrachloroethene	9	W=0.8854; Lognormal	0.8722	8	H=2.902	51.22	76	51.22
Chlorobenzene	9	W=0.9274; Normal	1.960	8	T=1.860	6.77	8.0	6.77
1,4-Dichlorobenzene	9	W=0.8909; Normal	2.421	8	T=1.860	6.39	9.0	6.39
Trichloroethene	6	W=0.9388; Lognormal	1.048	5	H=3.698	130	52	52

NOTES:

W = Shapiro-Wilk statistic. The value listed was determined by computing W using both raw and log transformed data, then choosing the greater value to determine the data set's most representative distribution.

Distribution significance determined at the alpha = 0.05 quantile based on n (Table A7, Gilbert, 1987).

From Table A12, Gilbert, 1987.

From Table A2, Gilbert, 1987.

The null hypotheses (of a normal and lognormal distribution) are rejected,

as W is less than the quantile at alpha = 0.05 (or any notable alpha error level) based on n. However, as the W value for a lognormal distribution is greater than the normal W value, the lognormal UCL is assumed to be the most representative, and will be calculated.

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TABLE 17D
STATISTICAL EVALUATION FOR AREA 2 GROUNDWATER COPCs
BUSH VALLEY LANDFILL

COPC (Total)	n	LOGNORMAL OR NORMAL DIST. AND ASSOCIATED "W" VALUE[1]	LOG-TRANSFORMED STANDARD DEVIATION	DEGREES OF FREEDOM	$H_{.95}$ (LOGNORMAL)[2] OR $T_{.95}$ (NORMAL)[3] VALUE	NORMAL OR LOGNORMAL UCL (ug/l)	MAXIMUM VALUE (ug/l)	MAXIMUM OR UCL VALUE DETERMINATION (ug/l)
Beryllium	6	W=0.7805; Normal	1.348	5	T=2.015	2.726	3.3	2.726
Manganese	6	W=0.9478; Lognormal	0.2493	5	H=1.992	7450	8620	7450
1,2-Dichloroethane	6	W=0.8994; Lognormal	0.5364	5	H=2.465	12.61	13	12.61
Vinyl Chloride	6	W=0.4963; Lognormal[4]	0.2085	5	H=1.992	5.65	3	3
Alpha-BHC	6	W=0.4963; Normal[5]	0.0078	5	T=2.015	0.028	0.012	0.012

NOTES:
1 W = Shapiro-Wilk statistic. The value listed was determined by computing W using both raw and log transformed data, then choosing the greater value to determine the data set's most representative distribution. Distribution significance determined at the alpha = 0.05 quantile based on n (Table A7, Gilbert, 1987).
2 From Table A12, Gilbert, 1987.
3 From Table A2, Gilbert, 1987.
4 The null hypotheses (of a normal and lognormal distribution) are rejected, as W is less than the quantile at alpha = 0.05 (or any notable alpha error level) based on n. However, as the W value for a lognormal distribution is greater than the normal W value, the lognormal UCL is assumed to be the most representative, and will be calculated.
5 The null hypotheses (of a normal and lognormal distribution) are rejected, as W is less than the quantile at alpha = 0.05 (or any notable alpha error level) based on n. However, as the W value for a normal distribution is greater than the lognormal W value, the normal UCL is assumed to be the most representative, and will be calculated.

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TABLE 18
INORGANIC DATA EVALUATION FOR SUBSURFACE SOIL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detect/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (mg/kg)	RANGE OF CONCENTRATION MAXIMUM[3] (mg/kg)	MAXIMUM POSITIVE CONCENTRATION GM5 (mg/kg)	MAXIMUM POSITIVE CONCENTRATION GM8 (mg/kg)	MAXIMUM POSITIVE CONCENTRATION GM1LSS (mg/kg)	MAXIMUM POSITIVE CONCENTRATION GM7 (mg/kg)	MAXIMUM POSITIVE CONCENTRATION GM9 (mg/kg)	10^{-6}/HQ = 0.1 RISK BASED CONCENTRATION (mg/kg)	COPC? GM5	COPC? GM8
		ONSITE SUBSURFACE SOIL[4]									
Aluminum	9/9	3380J	9200J	9200J	7910J	944J	931J	2470J	23,000		
Arsenic	2/9	0.71J	1.7J	--	--	<0.49	0.63J	13.4J	2.3[5]		
Barium	9/9	10.7J	55.7J	52.2	55.7J	6.3J	70.3	8.5J	550		
Beryllium	9/9	0.27J	1J	1J	0.81J	0.26J	0.63J	0.62J	0.15	YES	YES
Cadmium	3/9	3.1	8.6	3.1	8.6	<1.2	<1.4	<1.2	7.8[6]	YES	YES
Calcium	9/9	106J	1510	1510	748J	88.4J	698J	1510			
Chromium	9/9	11	28	24.2	22.3	21.8	16.7	44.9	39		
Cobalt	9/9	3.9J	30.6	30.6	14J	<3.5	10.7	182			
Copper	9/9	6.1	22.4	22.4	8.1	7.5	10	56.6	290		
Iron	9/9	4060J	13400J	13,400J	8460J	3930J	11,400J	4560J			
Lead	9/9	1.2	4.6	4.1	4.6	2.7	4	15.3			
Magnesium	9/9	560	3180	3180	1060J	74.2J	1990	1190	1095[6]		
Manganese	9/9	33.5	300	300	225	10.2	200	43.3			
Mercury	9/9	0.18	0.18	--	--	<0.12	0.17	<0.11	2.3		
Nickel	9/9	4.5J	17.6	13.8	17.6	4.2J	9.2J	178	160		
Potassium	9/9	171J	629J	565J	515J	41.2	564J	103J			
Selenium	0/9	--	--	--	--	<0.25	<0.28	0.67J	39		
Silver	1/9	1.5J	1.5J	1.5J	--	<1.5	<1.7	<1.4	39		
Sodium	9/9	47.2J	1540J	1010	1540J	114J	60.4J	121J			
Vanadium	9/9	12.5	43.9	42	25.9	34.2	27.6	39.3	55		
Zinc	9/9	10.6	65.7	65.7	59.4	8.2	30.3	238	2300		
Boron	1/9	2.5J	2.5J	--	--	<2	<2.2	2.4J	700		
Tin	9/9	43.9J	99.6J	99.6J	68.9J	66.5J	42.8J	85J	4700		

NOTE:

1. Number of times constituent was detected above the detection limit. Sample results from duplicates were consolidated into a single result using the higher detected concentration of each constituent.
2. Number of samples taken and analyzed for the constituent. Sample number may vary based on number of usable samples.
3. Minimum and Maximum detected concentrations above the sample quantitation limit.
4. Onsite subsurface soil consists of all borings except GM1LSS, GM7 and GM9, and GM1US.
5. Based on arsenic RfD; see also discussion of arsenic carcinogenicity.
6. Based on RfD for chemical in food.

-- Not detected

AR302177

TABLE 18A
ORGANIC DATA EVALUATION FOR SUBSURFACE SOIL
BUSH VALLEY LANDFILL

PARAMETER	FREQUENCY OF DETECTION (# Detects/# Samples[2])	RANGE OF CONCENTRATION ONSITE SUBSURFACE SOIL[4]		MAXIMUM POSITIVE CONCENTRATION GM5 (ug/kg)	MAXIMUM POSITIVE CONCENTRATION GM8 (ug/kg)	MAXIMUM POSITIVE CONCENTRATION GM1LSS (ug/kg)	MAXIMUM POSITIVE CONCENTRATION GM7 (ug/kg)	MAXIMUM POSITIVE CONCENTRATION GM9 (ug/kg)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/kg)	COPC? GM5	COPC? GM8
		MINIMUM[3] (ug/kg)	MAXIMUM[3] (ug/kg)								
VOCs											
1,2-Dichloroethane	0/9	---	---	---	---	<12	3J	<12	7,000		
Methylene Chloride	1/9	7J	7J	---	---	B	B	B	85,000		
Acetone	1/9	490J	490J	---	---	<12	<14	22J	780,000		
Carbon Disulfide	2/9	4J	14J	---	4J	<12	<14	5J	780,000		
1,1-Dichloroethane	1/9	4J	4J	---	---	<12	<14	<12	780,000		
2-Butanone	2/9	7J	7BJ	---	7BJ	<12	25J	<12	390,000		
Benzene	1/9	3J	3J	---	---	<12	<14	5J	22,000		
Toluene	3/9	3J	12J	---	12J	<12	<14	3J	1,600,000		
Trichloroethene	1/9	4J	4J	---	4J	<12	<14	<12	47,000		
SVOCs											
Di-n-butylphthalate	1/9	190J	190J	---	---	<410	<470	<40J	780,000		
PESTICIDE/PCB											
Aroclor-1254	8/9	19J	250J	24J	250J	150J	<23	<40	83	YES	YES

NOTE:

[1] Number of times constituent was detected above the detection limit.
Sample results from duplicates were consolidated into a single sample result using the higher detected concentration of each constituent.
[2] Number of samples taken and analyzed for the constituent. Sample number may very based on number of usable samples.
[3] Minimum and maximum detected concentrations above the detection limit.
[4] Onsite subsurface soil consists of all borings except GM1LSS, GM7 and GM9.

--- Not detected.

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TABLE 18B
CONTAMINANT OF POTENTIAL CONCERN
SUBSURFACE SOIL
BUSH VALLEY LANDFILL

PARAMETER	REPRESENTATIVE CONCENTRATION ONSITE SUBSURFACE SOIL[1]	
	GM5 (mg/kg)	GM8 (mg/kg)
Beryllium	1J	0.81J
Cadmium	3.1	8.6
Aroclor−1254	0.024J	0.25J

NOTES:

[1]   Representative concentration is equivalent to the
maximum positive concentration.

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TABLE 19
SOIL AND NON-COVERED SEDIMENT EXPOSURE SCENARIO
FOR CHILDREN AND ADULT RESIDENTS
INGESTION, AND DERMAL CONTACT
BUSH VALLEY LANDFILL

EXPOSURE PARAMETERS	VALUES		REFERENCES
	Child	Adult	
Age	1 to 6 years	7 years to Adult	EPA, 1991[1]
Body Weight (BW)	15 kg	70 kg	EPA, 1991[1]
Frequency of Exposure (EF)	350 days/year	350 days/year	EPA, 1991[1]
Duration of Exposure (ED)	6 years	24 years	EPA, 1991[1]
Averaging Time (AT) carcinogen	365 days/year x 70 years	365 days/year x 70 years	EPA, 1991[1]
Averaging Time (AT) non-carcinogen	365 days/year x 6 years	365 days/year x 24 years	EPA, 1991[1]
Soil Ingestion Rate (IR soil)	200 mg/day	100 mg/day	EPA, 1991[1]
Sediment Ingestion Rate (IR sed)	200 mg/day	100 mg/day	EPA, 1991[1]
Inhalation Rate (IR air)	12 m³/day	20 m³/day	EPA, 1991[1]
Surface Area Exposed (SA)	1800 cm²	3000 cm²	EPA, 1989[2](hands, arms and feet); EPA, 1989[3]
Permeability Coefficient (PC)	chemical-specific	chemical-specific	EPA, 1992[2]
Fraction Ingested from Source (Fi)	1	1	Prof. judgment
Absorption Fraction (ABS)	Oral: 1; Dermal VOAs: 0.1; Dermal BNAs: 0.03; Dermal Cd: 0.01; Dermal pesticides: 0.05; Dermal PCBs: 0.06		
Soil-to-skin Adherence Factor (AF)	1 mg/cm²	1 mg/cm²	EPA, 1992[2]

1 U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors, Interim Final. Washington, D.C., March 1991.

2 U.S. Environmental Protection Agency (USEPA). Exposure Factors Handbook. USEPA/600/8-89/043. Office of Health and Environmental Assessment. Washington, D.C., July 1989.

3 U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual (Part A), Interim Final. Washington, D.C., December 1989.

4 U.S. Environmental Protection Agency (USEPA). Dermal Exposure Assessment: Principles and Applications. USEPA/600/8-91/011/B. Office of Health and Environmental Assessment. Washington, D.C., January 1992.

TABLE 20

COVERED SEDIMENT EXPOSURE SCENARIO FOR CHILDREN AND ADULT RESIDENTS (WADING)
INGESTION AND DERMAL CONTACT
BUSH VALLEY LANDFILL

EXPOSURE PARAMETERS	VALUES		REFERENCES
	Child	Adult	
Age	1 to 6 years	7 years to Adult	EPA, 1991[1]
Body Weight (BW)	15 kg	70 kg	EPA, 1991[1]
Frequency of Exposure (EF)	7 days/year	7 days/year	EPA, 1991[1]
Duration of Exposure (ED)	6 years	24 years	EPA, 1991[1]
Averaging Time (AT) carcinogen	365 days/year x 70 years	365 days/year x 70 years	EPA, 1991[1]
Averaging Time (AT) non-carcinogen	365 days/year x 6 years	365 days/year x 24 years	EPA, 1991[1]
Soil Ingestion Rate (IR soil)	200 mg/day	100 mg/day	EPA, 1991[1]
Sediment Ingestion Rate (IR sed)	200 mg/day	100 mg/day	EPA, 1991[1]
Surface Area Exposed (SA)	860 cm²	1800 cm²	EPA, 1989[2] (Hands & feet), EPA, 1989[3]
Permeability Coefficient (PC)	chemical-specific	chemical-specific	EPA, 1992[4]
Fraction ingested from source (Fi)	1	1	Prof. judgment
Absorption Fraction (ABS)	Oral: 1; Dermal VOAs: 0.1; Dermal BNAs: 0.03; Dermal Cd: 0.01; Dermal pesticides: 0.05; Dermal PCBs: 0.06		EPA, 1992[4]: Prof. judgment
Soil-to-skin Adherence Factor (AF)	1 mg/cm²	1 mg/cm²	EPA, 1992[4]

U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors, Interim Final. Washington, D.C., March 1991.

U.S. Environmental Protection Agency (USEPA). Exposure Factors Handbook. USEPA/600/8-89/043. Office of Health and Environmental Assessment. Washington, D.C., July 1989.

U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual (Part A), Interim Final. Washington, D.C., December 1989.

U.S. Environmental Protection Agency (USEPA). Dermal Exposure Assessment: Principles and Applications. USEPA/600/8-91/011/B. Office of Health and Environmental Assessment. Washington, D.C., January 1992.

TABLE 21
GROUNDWATER EXPOSURE SCENARIO FOR CHILDREN AND ADULT RESIDENTS
INGESTION, DERMAL CONTACT AND INHALATION
BUSH VALLEY LANDFILL

EXPOSURE PARAMETERS	VALUES Child	Adult	REFERENCES
Age	1 to 6 years	7 years to Adult	EPA. 1991[1]
Body Weight (BW)	15 kg	70 kg	EPA. 1991[1]
Frequency of Exposure (EF)	350 days/year	350 days/year	EPA. 1991[1]
Duration of Exposure (ED)	6 years	24 years	EPA. 1991[1]
Averaging Time (AT) carcinogen	365 days/year x 70 years	365 days/year x 70 years	EPA. 1991[1]
Averaging Time (AT) non−carcinogen	365 days/year x 6 years	365 days/year x 24 years	EPA. 1991[1]
Daily Water Ingestion Rate (IRw)	1 L/day	2 L/day	EPA. 1991[1]
Inhalation Rate (IR air) or (VR)	NA	(14 L/min)20 m³/day	EPA. 1991[1]
Surface Area Exposed (SA) or (A)	7200 cm²	18,000 cm²	EPA, 1989[2]
Permeability Coefficient (PC) or (Kp)	chemical−specific	chemical−specific	EPA, 1992[3]
Time of Bath or Shower (t) or (D,)	0.33 hrs	12 min; 0.2 hrs	
Shower Temperature (T,)	N/A	318 K	Foster & Chrostowski, 1987
Lag Time (T)	Chemical−specific	Chemical−specific	EPA, 1992[3]
Time (t*)	Chemical−specific	Chemical−specific	EPA, 1992[3]
Partitioning Constant (B)	Chemical−specific	Chemical−specific	EPA, 1992[3]
Calibration Water Temperature of of Mass Transfer Coefficient (T,)	N/A	293K	Foster & Chrostowski, 1987
Water Viscosity at T, (u,)	N/A	1.002 centipoise	Foster & Chrostowski, 1987
Water Viscosity at T, (u,)	N/A	0.596 centipoise	Foster & Chrostowski, 1987
Henry's Law Constant (H)	Chemical−specific	Chemical−specific	
Molecular Weight (MW)	Chemical−specific	Chemical−specific	
Shower Droplet Time (t,)	N/A	2 sec	Foster & Chrostowski, 1987
Shower Droplet Diameter (d)	N/A	1 mm	Foster & Chrostowski, 1987
Shower Flow Rate (FR)	N/A	20 L/min	Prof. judgment
Shower Room Volume (SV)	N/A	6m³	Foster & Chrostowski, 1987
Total Time in Shower Room (Dt)	N/A	20 min	Foster & Chrostowski, 1987
Rate of Air Exchange (Ra)	N/A	0.01667 min⁻¹	Foster & Chrostowski, 1987

[1]   U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors, Interim Final. Washington, D.C., March 1991.

[2]   U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual (Part A), Interim Final. Washington, D.C., December 1989.

[3]   U.S. Environmental Protection Agency (USEPA). Dermal Exposure Assessment: Principles and Applications. USEPA/600/8−91/011B. Office of Health and Environmental Assessment. Washington, D.C., January 1992.

TABLE 22
SURFACE WATER EXPOSURE SCENARIO FOR CHILDREN AND ADULT RESIDENTS (WADING)
INGESTION AND DERMAL CONTACT
BUSH VALLEY LANDFILL

EXPOSURE PARAMETERS	VALUES		REFERENCES
	Child	Adult	
Age	1 to 6 years	7 years to Adult	EPA, [1]
Body Weight (BW)	15 kg	70 kg	EPA, 1991[1]
Frequency of Exposure (EF)	7 days/year	7 days/year	EPA, 1991[1]
Duration of Exposure (ED)	6 years	24 years	EPA, 1991[1]
Averaging Time (AT) carcinogen	365 days/year x 70 years	365 days/year x 70 years	EPA, 1991[1]
Averaging Time (AT) non-carcinogen	365 days/year x 6 years	365 days/year x 24 years	EPA, 1991[1]
Daily Water Ingestion Rate (IR w)	.065 L/day	.065 L/day	EPA 1989[2] & Prof. judgment that wading surface water ingestion = 1/2 swimming
Surface Area Exposed (SA) or (A)	2700 cm²	3800 cm²	EPA 1989[2], EPA 1989[3] (hands, legs & feet)
Permeability Coefficient (PC) or (Kp)	chemical-specific	chemical-specific	EPA, 1992[4]
Lag Time (T)	chemical-specific	chemical-specific	EPA, 1992[4]
Time (t*)	chemical-specific	chemical-specific	EPA, 1992[4]
Partitioning Constant (B)	chemical-specific	chemical-specific	EPA, 1992[4]
Duration of Swimming/Wading Event (t)	2.6 hrs.	2.6 hrs.	EPA 1989[2]

[1] U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors, Interim Final. Washington, D.C., March 1991.

[2] U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual (Part A), Interim Final. Washington, D.C., December 1989.

[3] U.S. Environmental Protection Agency (USEPA). Exposure Factors Handbook. USEPA/600/8-89/043. Office of Health and Environmental Assessment. Washington, D.C., July 1989.

[4] U.S. Environmental Protection Agency (USEPA). Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011/B. Office of Health and Environmental Assessment. Washington, D.C., January 1992.

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TABLE 23
LEACHATE EXPOSURE SCENARIO FOR CHILD AND ADULT RESIDENTS
INGESTION AND DERMAL CONTACT
BUSH VALLEY LANDFILL

EXPOSURE PARAMETERS	VALUES		REFERENCES
	Child	Adult	
Age	1 to 6 years	7 years to Adult	EPA, 1991[1]
Body Weight (BW)	15 kg	70 kg	EPA, 1991[1]
Frequency of Exposure (EF)	120 days/year	120 days/year	Prof. judgment (site-specific)
Duration of Exposure (ED)	6 years	24 years	EPA, 1991[1]
Averaging Time (AT) carcinogen	365 days/year x 70 years	365 days/year x 70 years	EPA, 1991[1]
Averaging Time (AT) non-carcinogen	365 days/year x 6 years	365 days/year x 24 years	EPA, 1991[1]
Daily Water Ingestion Rate (IR w)	.001L/exposure	.001L/exposure	Prof. judgment
Surface Area Exposed (SA) or (A)	1800 cm^2	3000 cm^2	EPA. 1989[2] (hands, arms & feet); EPA 1989[3]
Permeability Coefficient (PC) or (Kp)	chemical-specific	chemical-specific	EPA, 1992[4]
Lag Time (T)	chemical-specific	chemical-specific	EPA, 1992[4]
Time (t*)	chemical-specific	chemical-specific	EPA, 1992[4]
Partitioning Constant (B)	chemical-specific	chemical-specific	EPA, 1992[4]
Duration of exposure (t)	2.6 hours/day	2.6 hours/day	EPA 1989[3] (based on duration of recreational activity such as swimming)

U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors, Interim Final. Washington, D.C., March 1991.

U.S. Environmental Protection Agency (USEPA). Exposure Factors Handbook. USEPA/600/8-89/043. Office of Health and Environmental Assessment. Washington, D.C., July 1989.

U.S. Environmental Protection Agency (USEPA). Risk Assessment Guidance for Superfund Vol.I: Human Health Evaluation Manual (Part A), Interim Final. Washington, D.C., December 1989.

U.S. Environmental Protection Agency (USEPA). Dermal Exposure Assessment: Principles and Applications. USEPA/600/8-91/011/B. Office of Health and Environmental Assessment. Washington, D.C., January 1992.

TABLE 24
INORGANIC DATA EVALUATION FOR WELL GM1US
BUSH VALLEY LANDFILL

PARAMETER (unfiltered)	FREQUENCY OF DETECTION (# Detects[1]/# Samples[2])	RANGE OF CONCENTRATION MINIMUM[3] (ug/l)	MAXIMUM[3] (ug/l)	MCL (ug/l)	10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l)	COPC ?
Aluminum	1/2	120 J	120 J	50–200[4]	11,000	
Barium	2/2	51.4 J	60.3 J	2,000	260	
Beryllium	1/2	1.2 J	1.2 J	4	0.019	YES
Calcium	2/2	60700	61400			
Cobalt	2/2	355	452			
Iron	2/2	2750	8090	300[4]		
Magnesium	2/2	22300	27100			
Manganese	2/2	3440	4270	50[4]	18	YES
Nickel	2/2	628	789	100	73	YES
Potassium	2/2	8760	8840			
Sodium	2/2	107000	118000			
Zinc	2/2	234	347	5000[4]	1100	

NOTES:

1   Number of times constituent was detected above the detection limit.
2   Number of samples taken and analyzed for the constituent.
3   Minimum and maximum detected concentrations above the detection limit.
4   SMCL

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TABLE 25
ORGANIC DATA EVALUATION FOR WELL GM1US
BUSH VALLEY LANDFILL

| PARAMETER | FREQUENCY OF DETECTION (# Detects[1]/# Samples[2]) | RANGE OF CONCENTRATION | | MCL (ug/l) | 10^{-6}/HQ=0.1 RISK BASED CONCENTRATION (ug/l) | COPC ? |
		MINIMUM [3] (ug/l)	MAXIMUM [3] (ug/l)			
Benzene	1/2	3.00 J	3.00 J	5	0.35	YES
1,1 - Dichloroethane	1/2	3.00 J	3.00 J		81	
Tetrachloroethene	2/2	30.00	34.00	5	1.3	YES
Trichloroethene	1/2	11.00	11.00	5	1.9	YES

NOTES:

1 Number of times constituent was detected above the detection limit.
2 Number of samples taken and analyzed for the constituent.
3 Minimum and maximum detected concentrations above the detection limit.

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TABLE 26
CONTAMINANTS OF POTENTIAL CONCERN IN WELL GM1US
BUSH VALLEY LANDFILL

PARAMETER (unfiltered)	REPRESENTATIVE CONCENTRATION[1] (ug/l)
Beryllium	1.2 J
Manganese	4270
Nickel	789
Benzene	3.00J
Tetrachloroethene	34.00
Trichloroethene	11.00

[1] Representative concentration is equivalent to the maximum positive concentration.

ADULT	MILTON	FLEET WASHING-TON		SPLIT STREAM SED	MARSH SED 1	MARSH SED 2
MANGANESE	0.13	0.12	0.61	N/A	N/A	N/A
BERYLLIUM	N/A	N/A	N/A	0.000019	0.0002	0.00026
ARSENIC	N/A	N/A	N/A	N/A	0.012	0 014
CHROMIUM	N/A	N/A	N/A	N/A	0.012	0.013
VANADIUM	N/A	N/A	N/A	N/A	0.012	0.013
ALUMINUM	N/A	N/A	N/A	N/A	N/A	0.012
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.13	0.12	0.61	0.000019	0.0362	0.05226
CHILD						
MANGANESE	0.3	0.28	1.4	N/A	N/A	N/A
BERYLLIUM	N/A	N/A	N/A	0.000017	0.0019	0.0025
ARSENIC	N/A	N/A	N/A	N/A	0.11	0.13
CHROMIUM	N/A	N/A	N/A	N/A	0.11	0.12
VANADIUM	N/A	N/A	N/A	N/A	0.12	0.12
ALUMINUM	N/A	N/A	N/A	N/A	N/A	0.11
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.3	0.28	1.4	0.000017	0.3419	0.4825

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TABLE 27 PAGE 2/4
SUMMARY OF QUANTITATIVE NONCANCER RISKS
BUSH VALLEY LANDFILL

ADULT	SPLIT MARSH SED 2	SURF SOIL	SPLIT SURF SOIL	SURF DUST	SW–7	SD–2
MANGANESE	N/A	N/A	N/A	0.013	0.063	0.019
BERYLLIUM	0.00026	0.00015	0.00015	N/A	N/A	0.00018
ARSENIC	0.024	N/A	0.016	N/A	N/A	0.017
CHROMIUM	0.013	0.057	0.057	0.09	N/A	N/A
VANADIUM	0.013	0.01	0.01	N/A	N/A	N/A
ALUMINUM	0.012	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4–DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA–HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.06226	0.06715	0.08315	0.103	0.063	0.03618
CHILD						
MANGANESE	N/A	N/A	N/A	0.038	0.25	0.18
BERYLLIUM	0.0025	0.0014	0.0014	N/A	N/A	0.0017
ARSENIC	0.22	N/A	0.15	N/A	N/A	0.16
CHROMIUM	0.12	0.53	0.53	0.26	N/A	N/A
VANADIUM	0.12	0.097	0.097	N/A	N/A	N/A
ALUMINUM	0.11	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2–DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4–DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA–HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.5725	0.6284	0.7784	0.298	0.25	0.3417

TABLE 27 PAGE 3/4
SUMMARY OF QUANTITATIVE NONCANCER RISKS
BUSH VALLEY LANDFILL

ADULT	SD-7	SPLIT SD-9	LEACH	MW AREA 1	SPLIT MW AREA 1	MW AREA 2
MANGANESE	0.00039	N/A	0.088	14	14	41.7
BERYLLIUM	0.000004	0.00012	N/A	0.0073	0.0073	0.017
ARSENIC	0.00028	0.031	N/A	0.32	0.46	N/A
CHROMIUM	0.00021	N/A	N/A	0.089	0.089	N/A
VANADIUM	0.00025	0.011	N/A	N/A	N/A	N/A
ALUMINUM	0.00021	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	0	0	0
1,2-DICHLOROETHENI	N/A	N/A	N/A	0.018	0.018	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	0.94	0.94	0.16
1,2-DICHLOROPROPAI	N/A	N/A	N/A	0.33	0.33	N/A
BENZENE	N/A	N/A	N/A	0.14	0.14	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	0.49	0.49	N/A
CHLOROBENZENE	N/A	N/A	N/A	0.056	0.056	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	0.00096	0.00096	N/A
TRICHLOROETHENE	N/A	N/A	N/A	0.51	0.51	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	0.011	N/A
CADMIUM	N/A	N/A	N/A	N/A	0.33	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	0
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.001344	0.04212	0.088	16.90126	17.38226	41.877
CHILD						
MANGANESE	0.0036	N/A	0.27	33.1	33.1	95.2
BERYLLIUM	0.00004	0.0012	N/A	0.017	0.017	0.043
ARSENIC	0.0026	0.29	N/A	0.75	1.1	N/A
CHROMIUM	0.002	N/A	N/A	0.21	0.21	N/A
VANADIUM	0.0024	0.1	N/A	N/A	N/A	N/A
ALUMINUM	0.002	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	0	0	0
1,2-DICHLOROETHENI	N/A	N/A	N/A	0.043	0.043	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	0	0	0
1,2-DICHLOROPROPAI	N/A	N/A	N/A	0	0	N/A
BENZENE	N/A	N/A	N/A	0	0	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	1.6	1.6	N/A
CHLOROBENZENE	N/A	N/A	N/A	0.029	0.029	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	0	0	N/A
TRICHLOROETHENE	N/A	N/A	N/A	1.6	1.6	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	0.026	N/A
CADMIUM	N/A	N/A	N/A	N/A	0.77	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	0
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.01264	0.3912	0.27	37.349	38.495	95.243

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SUMMARY OF QUANTITATIVE NONCANCER RISKS
BUSH VALLEY LANDFILL

ADULT	SB-5	SB-8	WELL GM1US
MANGANESE	N/A	N/A	23.4
BERYLLIUM	0.00027	0.00022	0.0078
ARSENIC	N/A	N/A	N/A
CHROMIUM	N/A	N/A	N/A
VANADIUM	N/A	N/A	N/A
ALUMINUM	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A
BENZENE	N/A	N/A	0.08
TETRACHLOROETHENI	N/A	N/A	0.32
CHLOROBENZENE	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	0.11
HEPTACHLOR EPOXIDI	N/A	N/A	N/A
CADMIUM	0.0055	0.015	N/A
ALPHA-HCH	N/A	N/A	N/A
AROCLOR 1254	0	0	N/A
NICKEL	N/A	N/A	1.1
TOTAL	0.00577	0.01522	25.0178

CHILD			
MANGANESE	N/A	N/A	55.1
BERYLLIUM	0.0026	0.0021	0.019
ARSENIC	N/A	N/A	N/A
CHROMIUM	N/A	N/A	N/A
VANADIUM	N/A	N/A	N/A
ALUMINUM	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A
BENZENE	N/A	N/A	0
TETRACHLOROETHENI	N/A	N/A	1.1
CHLOROBENZENE	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	0.35
HEPTACHLOR EPOXIDI	N/A	N/A	N/A
CADMIUM	0.044	0.12	N/A
ALPHA-HCH	N/A	N/A	N/A
AROCLOR 1254	0	0	N/A
NICKEL	N/A	N/A	2.5
TOTAL	0.0466	0.1221	59.069

FOR EVALUATION OF LEAD IN FLEET AND LEACHATE, SEE TEXT

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	MILTON	FLEET	WASHING-TON	SPLIT STREAM SED	MARSH SED 1	MARSH SED 2
MANGANESE	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A
BERYLLIUM	N/A	N/A	N/A	4.60E-08	5.00E-06	6.40E-06
ARSENIC	N/A	N/A	N/A	N/A	7.10E-06	8.40E-06
CHROMIUM	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00
VANADIUM	N/A	N/A	N/A	N/A	0.00E+00	0.00E+00
ALUMINUM	N/A	N/A	N/A	N/A	N/A	0.00E+00
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	0.00E+00	0.00E+00	0.00E+00	4.60E-08	1.21E-05	1.48E-05

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	SPLIT MARSH SED 2	SURF SOIL	SPLIT SURF SOIL	SURF DUST	SW-7	SD-2
MANGANESE	N/A	N/A	N/A	0.00E+00	0.00E+00	0.00E+00
BERYLLIUM	6.40E-06	3.60E-06	3.60E-06	N/A	N/A	4.40E-06
ARSENIC	1.43E-05	N/A	9.60E-06	N/A	N/A	1.01E-05
CHROMIUM	0.00E+00	0.00E+00	0.00E+00	1.31E-06	N/A	N/A
VANADIUM	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A
ALUMINUM	0.00E+00	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDI	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	2.07E-05	3.60E-06	1.32E-05	1.31E-06	0.00E+00	1.45E-05

	SD-7	SPLIT SD-9	LEACH	MW AREA 1	SPLIT MW AREA 1	MW AREA 2
MANGANESE	0.00E+00	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BERYLLIUM	1.06E-07	3.01E-06	N/A	8.65E-05	8.65E-05	2.09E-04
ARSENIC	1.71E-07	1.86E-05	N/A	9.22E-05	1.30E-04	N/A
CHROMIUM	0.00E+00	N/A	N/A	0.00E+00	0.00E+00	N/A
VANADIUM	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A
ALUMINUM	0.00E+00	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	3.39E-04	3.39E-04	1.03E-04
1,2-DICHLOROETHENI	N/A	N/A	N/A	0.00E+00	0.00E+00	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	1.91E-04	1.91E-04	3.18E-05
1,2-DICHLOROPROPAI	N/A	N/A	N/A	1.02E-05	1.02E-05	N/A
BENZENE	N/A	N/A	N/A	5.66E-06	5.66E-06	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	1.62E-04	1.62E-04	N/A
CHLOROBENZENE	N/A	N/A	N/A	0.00E+00	0.00E+00	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	3.25E-06	3.25E-06	N/A
TRICHLOROETHENE	N/A	N/A	N/A	2.48E-05	2.48E-05	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	9.76E-07	N/A
CADMIUM	N/A	N/A	N/A	N/A	0.00E+00	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	1.94E-06
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	2.77E-07	2.16E-05	0.00E+00	9.15E-04	9.54E-04	3.46E-04

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SUMMARY OF QUANTITATIVE CANCER RISKS
BUSH VALLEY LANDFILL

	SB-5	SB-8	WELL GM1US
MANGANESE	N/A	N/A	0.00E+00
BERYLLIUM	6.70E-06	5.40E-06	9.14E-05
ARSENIC	N/A	N/A	N/A
CHROMIUM	N/A	N/A	N/A
VANADIUM	N/A	N/A	N/A
ALUMINUM	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A
BENZENE	N/A	N/A	3.28E-06
TETRACHLOROETHENI	N/A	N/A	1.15E-04
CHLOROBENZENE	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	5.22E-06
HEPTACHLOR EPOXIDE	N/A	N/A	N/A
CADMIUM	0.00E+00	0.00E+00	N/A
ALPHA-HCH	N/A	N/A	N/A
AROCLOR 1254	5.87E-07	6.10E-06	N/A
NICKEL	N/A	N/A	0.00E+00
TOTAL	7.29E-06	1.15E-05	2.15E-04

TABLE 29
NONCANCER RISKS: HAZARD INDICES FOR SUMMATION ACROSS PATHWAYS
BUSH VALLEY LANDFILL

ADULT
WATER SOURCES

FLEET	0.12 Mn		
MILTON	0.13 Mn		

SOIL/SEDIMENT FREQUENT CONTACT

SURF. SOIL	0.067 Cr	DUST	0.1 Cr
+ SPLIT	0.083 Cr, As		
MARSH 1	0.036 Cr, As, V		
MARSH 2	0.052 Cr, As, V, Al		
+ SPLIT	0.061 Cr, As, V, Al		
SD9	0.042 As, V		
SD2	0.036 As, Mn		
SB5	0.0057		
SB8	0.015		

INTERMITTENT CONTACT

STREAM SED.	0.000002
SW7/SD7	0.064 Mn
LEACHATE	0.088 Mn

CHILD
WATER SOURCES

FLEET	0.28 Mn
MILTON	0.3 Mn

SOIL/SEDIMENT FREQUENT CONTACT

SURF. SOIL	0.62 Cr,V	DUST	0.3 Cr
+ SPLIT	0.77 As,Cr,V		
MARSH 1	0.34 Cr, As, V		
MARSH 2	0.48 Cr, As, V, Al		
+ SPLIT	0.57 Cr, As, V, Al		
SD9	0.39 As, V		
SD2	0.34 As, Mn		
SB5	0.046		
SB8	0.12 Cd		

INTERMITTENT CONTACT

STREAM SED.	0.000017
SW7/SD7	0.26 Mn
LEACHATE	0.27 Mn

TABLE 30
CANCER RISKS FOR SUMMATION ACROSS PATHWAYS
BUSH VALLEY LANDFILL

WATER SOURCES
FLEET   NC
MILTON   NC

SOIL/SEDIMENT FREQUENT CONTACT
SURF. SOIL   3.6E−06   DUST   1.3E−06
 + SPLIT   1.3E−05
MARSH 1   1.2E−05
MARSH 2   1.4E−05
 + SPLIT   2.0E−05
SD9   2.1E−05
SD2   1.4E−05
SB5   7.3E−06
SB8   1.2E−05

INTERMITTENT CONTACT
STREAM SED.   4.6E−08
SW7/SD7   2.7E−07
LEACHATE   NC

NC = NOT CALCULATED; INDIVIDUAL RISKS < 1E−6

TABLE 31
DOSE-RESPONSE PARAMETERS FOR THE CHEMICALS OF POTENTIAL CONCERN
BUSH VALLEY LANDFILL

CHEMICAL	ORAL RFD (MG/KG/DAY)	INHAL RFD	ORAL CSF (1/MG/KG/DAY)	INHAL CSF
ALUMINUM	2.90E+00			
AROCLOR 1254			7.70E+00	
ARSENIC	3.00E-04		1.75E+00	
BENZENE		1.70E-03	2.90E-02	2.90E-02
BERYLLIUM	5.00E-03		4.30E+00	8.40E+00
CADMIUM	5E-4 (W) 1E-3 (F)			6.30E+00
CHLOROBENZENE	2.00E-02	5.70E-03		
CHROMIUM	5.00E-03	5.71E-07		4.10E+01
1,4-DICHLOROBENZENE		2.30E-01	2.40E-02	
1,2-DICHLOROETHANE		2.90E-03	9.10E-02	9.10E-02
1,2-DICHLOROETHENE	9.00E-03			
1,2-DICHLOROPROPANE		1.10E-03	6.80E-02	
ALPHA-HEXACHLOROCYCLOHEXANE			6.30E+00	6.30E+00
MANGANESE	5E-3 (W) 1.4E-1 (F)	1.40E-05		
TETRACHLOROETHENE	1.00E-02		5.20E-02	2.00E-03
TRICHLOROETHENE	6.00E-03		1.10E-02	6.00E-03
VANADIUM	7.00E-03			
VINYL CHLORIDE			1.90E+00	3.00E-01
HEPTACHLOR EPOXIDE	1.30E-05		9.10E+00	9.10E+00
NICKEL	2.00E-02			

W = WATER   F = FOOD

TABLE 32
EXPOSURE SCENARIO SUMMARY FOR QUANTITATIVE RISK ASSESSMENT
BUSH VALLEY LANDFILL

EXPOSURE ROUTE AND RECEPTOR	MILTON WELL	FLEET WELL	WASHINGTON WELL	STREAM SED.	MARSH SED. 1	MARSH SED. 2	SURFACE SOIL	SW-7	SD-2	SD-7	SD-9	LEACHATE	MONITOR WELLS 1	MONITOR WELLS 2	SB-5	SB-8	WELL GM1US
ADULT RESIDENT: WATER INGESTION	X	X	X										X	X			X
ADULT RESIDENT: WATER DERMAL	X	X	X										X	X			X
ADULT RESIDENT: WATER INHALATION																	X
CHILD RESIDENT: WATER INGESTION	X	X	X										X	X			X
CHILD RESIDENT: WATER DERMAL	X	X	X										X	X			X
CHILD RESIDENT: UBK LEAD MODEL												X					
ADULT RESIDENT: SEDIMENT INGESTION, WADING										X							
ADULT RESIDENT: SEDIMENT DERMAL, WADING				X													
CHILD RESIDENT: SEDIMENT INGESTION, WADING										X							
CHILD RESIDENT: SEDIMENT DERMAL, WADING				X													
ADULT RESIDENT: SOIL INGESTION					X	X	X		X		X				X	X	
ADULT RESIDENT: SOIL DERMAL															X	X	
CHILD RESIDENT: SOIL INGESTION					X	X	X		X		X				X	X	
CHILD RESIDENT: SOIL DERMAL															X	X	
FUGITIVE DUST EMISSIONS							X										
ADULT RESIDENT: WATER INGESTION, WADING								X									
ADULT RESIDENT: WATER DERMAL, WADING								X									
CHILD RESIDENT: WATER INGESTION, WADING								X									
CHILD RESIDENT: WATER DERMAL, WADING								X									
ADULT RESIDENT: INGESTION												X					
ADULT RESIDENT: DERMAL												X					
CHILD RESIDENT: INGESTION												X					
CHILD RESIDENT: DERMAL												X					

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SUMMARY OF REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
BUSH VALLEY LANDFILL

	MILTON (UG/L)	FLEET WASHING- TON (UG/L)	(UG/L)	SPLIT STREAM SED (MG/KG)	MARSH SED 1 (MG/KG)	MARSH SED 2 (MG/KG)
MANGANESE	23.2	22.2	111	N/A	N/A	N/A
BERYLLIUM	N/A	N/A	N/A	0.34	0.74	0.96
ARSENIC	N/A	N/A	N/A	N/A	2.6	3.1
CHROMIUM	N/A	N/A	N/A	N/A	42.6	45.7
VANADIUM	N/A	N/A	N/A	N/A	63.4	67.6
ALUMINUM	N/A	N/A	N/A	N/A	N/A	24800
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
LEAD	N/A	5.2	N/A	N/A	N/A	N/A

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SUMMARY OF REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
BUSH VALLEY LANDFILL

	SPLIT MARSH SED 2 (MG/KG)	SURF SOIL (MG/KG)	SPLIT SURF SOIL (MG/KG)	SURF DUST (MG/KG)	SW-7 (UG/L)	SD-2 (MG/KG)
MANGANESE	N/A	N/A	N/A	737	4220	1970
BERYLLIUM	0.96	0.53	0.53	N/A	N/A	0.65
ARSENIC	5.2	N/A	3.5	N/A	N/A	3.7
CHROMIUM	45.7	207	207	207	N/A	N/A
VANADIUM	67.6	52.94	52.94	N/A	N/A	N/A
ALUMINUM	24800	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROETHANI	N/A	N/A	N/A	N/A	N/A	N/A
1,2-DICHLOROPROPAI	N/A	N/A	N/A	N/A	N/A	N/A
BENZENE	N/A	N/A	N/A	N/A	N/A	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	N/A	N/A	N/A
CHLOROBENZENE	N/A	N/A	N/A	N/A	N/A	N/A
1,4-DICHLOROBENZEI	N/A	N/A	N/A	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	N/A	N/A	N/A	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	N/A	N/A
CADMIUM	N/A	N/A	N/A	N/A	N/A	N/A
ALPHA-HCH	N/A	N/A	N/A	N/A	N/A	N/A
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
LEAD	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 33 PAGE 3/4
SUMMARY OF REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
BUSH VALLEY LANDFILL

	SD−7 (MG/KG)	SPLIT SD−9 (MG/KG)	LEACH (UG/L)	MW AREA 1 (UG/L)	SPLIT MW AREA 1 (UG/L)	MW AREA 2 (UG/L)
MANGANESE	1980	N/A	10700	2588	2588	7450
BERYLLIUM	0.78	0.45	N/A	1.125	1.125	2.726
ARSENIC	3.1	6.8	N/A	3.51	5	N/A
CHROMIUM	38.8	N/A	N/A	16.16	16.16	N/A
VANADIUM	64.5	54.7	N/A	N/A	N/A	N/A
ALUMINUM	22500	N/A	N/A	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A	10.03	10.03	3
1,2−DICHLOROETHENI	N/A	N/A	N/A	5.9	5.9	N/A
1,2−DICHLOROETHANI	N/A	N/A	N/A	75.51	75.51	12.61
1,2−DICHLOROPROPAI	N/A	N/A	N/A	9.53	9.53	N/A
BENZENE	N/A	N/A	N/A	5.32	5.32	N/A
TETRACHLOROETHENI	N/A	N/A	N/A	51.22	51.22	N/A
CHLOROBENZENE	N/A	N/A	N/A	6.77	6.77	N/A
1,4−DICHLOROBENZEI	N/A	N/A	N/A	6.39	6.39	N/A
TRICHLOROETHENE	N/A	N/A	N/A	52	52	N/A
HEPTACHLOR EPOXIDE	N/A	N/A	N/A	N/A	0.005	N/A
CADMIUM	N/A	N/A	N/A	N/A	5.8	N/A
ALPHA−HCH	N/A	N/A	N/A	N/A	N/A	0.012
AROCLOR 1254	N/A	N/A	N/A	N/A	N/A	N/A
NICKEL	N/A	N/A	N/A	N/A	N/A	N/A
LEAD	N/A	N/A	215	N/A	N/A	N/A

TABLE 33 PAGE 4/4
SUMMARY OF REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
BUSH VALLEY LANDFILL

	SB−5 (MG/KG)	SB−8 (MG/KG)	WELL GM1US (UG/L)
MANGANESE	N/A	N/A	4270
BERYLLIUM	1	0.81	1.2
ARSENIC	N/A	N/A	N/A
CHROMIUM	N/A	N/A	N/A
VANADIUM	N/A	N/A	N/A
ALUMINUM	N/A	N/A	N/A
VINYL CHLORIDE	N/A	N/A	N/A
1,2−DICHLOROETHENI	N/A	N/A	N/A
1,2−DICHLOROETHANI	N/A	N/A	N/A
1,2−DICHLOROPROPAI	N/A	N/A	N/A
BENZENE	N/A	N/A	3
TETRACHLOROETHENI	N/A	N/A	34
CHLOROBENZENE	N/A	N/A	N/A
1,4−DICHLOROBENZEI	N/A	N/A	N/A
TRICHLOROETHENE	N/A	N/A	11
HEPTACHLOR EPOXIDE	N/A	N/A	N/A
CADMIUM	3.1	8.6	N/A
ALPHA−HCH	N/A	N/A	N/A
AROCLOR 1254	0.024	0.25	N/A
NICKEL	N/A	N/A	789
LEAD	N/A	N/A	N/A

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TABLE 34
OVERALL SUMMARY OF QUANTITATIVE RISKS
BUSH VALLEY LANDFILL

EXPOSURE SOURCE	CHILD HAZARD INDEX	ADULT HAZARD INDEX	TOTAL CANCER RISK
MILTON	3.0E−01	1.3E−01	0.0E+00
FLEET	2.8E−01	1.2E−01	0.0E+00
WASHINGTON	1.4E+00	6.1E−01	0.0E+00
STREAM SED (SPLIT)	1.7E−05	1.9E−06	4.6E−08
MARSH SED 1	3.4E−01	3.6E−02	1.2E−05
MARSH SED 2	4.8E−01	5.2E−02	1.5E−05
MARSH SED 2 (SPLIT)	5.7E−01	6.1E−02	2.1E−05
SURF SOIL	6.2E−01	6.7E−02	3.6E−06
SURF SOIL (SPLIT)	7.7E−01	8.3E−02	1.3E−05
SURF DUST	3.0E−01	1.0E−01	1.3E−06
SW−7	2.5E−01	6.3E−02	0.0E+00
SD−2	3.4E−01	3.6E−02	1.5E−05
SD−7	1.3E−02	1.4E−03	2.8E−07
SD−9 (SPLIT)	3.9E−01	4.2E−02	2.2E−05
LEACHATE	2.7E−01	8.8E−02	0.0E+00
MW AREA 1	3.7E+01	1.7E+01	9.2E−04
MW AREA 1 (SPLIT)	3.8E+01	1.7E+01	9.5E−04
MW AREA 2	9.5E+01	4.2E+01	3.5E−04
SB−5	4.6E−02	5.7E−03	7.3E−06
SB−8	1.2E−01	1.5E−02	1.2E−05
WELL GM1US	5.9E+01	2.5E+01	2.1E−04

FOR EVALUATION OF LEAD IN FLEET AND LEACHATE, SEE TEXT

TABLE 35
SUMMARY OF RME VS. CENTRAL TENDENCY RISKS
BUSH VALLEY LANDFILL

EXPOSURE SOURCE	ADULT TOTAL HAZARD INDEX		CHILD TOTAL HAZARD INDEX	
	RME	CENTRAL	RME	CENTRAL
WASHINGTON	6.1E−01	3.8E−01	1.4E+00	8.9E−01
MARSH SED 1	3.6E−02	2.8E−02	3.4E−01	2.6E−01
MARSH SED 2	5.2E−02	4.1E−02	4.8E−01	3.8E−01
MARSH SED 2 (SPLIT)	6.1E−02	5.2E−02	5.7E−01	4.8E−01
SURF SOIL	6.7E−02	1.7E−02	6.2E−01	1.6E−01
SURF SOIL (SPLIT)	8.3E−02	3.3E−02	7.7E−01	3.0E−01
SD−2	3.6E−02	3.6E−02	3.4E−01	3.4E−01
SD−9 (SPLIT)	4.2E−02	4.0E−02	3.9E−01	3.9E−01
MW AREA 1	1.7E+01	7.2E+00	3.7E+01	1.5E+01
MW AREA 1 (SPLIT)	1.7E+01	7.6E+00	3.8E+01	1.6E+01
MW AREA 2	4.2E+01	2.3E+01	9.5E+01	5.3E+01
SB−5	5.7E−03	5.8E−03	4.6E−02	4.6E−02
SB−8	1.5E−02	1.5E−02	1.2E−01	1.2E−01
WELL GM1US	2.5E+01	1.6E+01	5.9E+01	3.7E+01

EXPOSURE SOURCE	TOTAL CANCER RISK	
	RME	CENTRAL
WASHINGTON	0.0E+00	0.0E+00
MARSH SED 1	1.2E−05	3.0E−06
MARSH SED 2	1.5E−05	3.0E−06
MARSH SED 2 (SPLIT)	2.1E−05	5.6E−06
SURF SOIL	3.6E−06	6.0E−07
SURF SOIL (SPLIT)	1.3E−05	3.7E−06
SD−2	1.5E−05	4.7E−06
SD−9 (SPLIT)	2.2E−05	7.0E−06
MW AREA 1	9.2E−04	1.4E−04
MW AREA 1 (SPLIT)	9.5E−04	1.5E−04
MW AREA 2	3.5E−04	5.4E−05
SB−5	7.3E−06	2.0E−06
SB−8	1.2E−05	3.7E−06
WELL GM1US	2.1E−04	4.5E−05

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Note: This is the final version of this document. Pages stamped "Draft" did not require revision from the draft. Unstamped pages have been revised.